FOURTH

ANNUAL REPORT

OF THE

FISHERY BOARD FOR SCOTLAND

Being for the Year 1885.

Presented to both Houses of Parliament in pursuance of Act 45 and 46 Vict., cap. 78.

EDINBURGH:
PRINTED BY NEILL & COMPANY.

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FOURTH ANNUAL REPORT.

TO THE RIGHT HONOURABLE

THE EARL OF DALHOUSIE, K.T.,

Her Majesty's Secretary for Scotland.

FISHERY BOARD FOR SCOTLAND,
EDINBURGH, 26*th May* 1886.

MY LORD,

We, the Members of the Fishery Board for Scotland, appointed under the Fishery Board (Scotland) Act, 1882, have the honour to submit our Fourth Annual Report, in terms of the fifth section of that Act, and of the fifth section of the Secretary for Scotland Act, 1885.

THE SEA AND SALMON FISHERIES OF SCOTLAND.

Fisheries most productive.

The fisheries of Scotland continue to be most productive. In 1885 the total quantity of herrings landed was, with the single exception of that of the preceding year, the greatest ever recorded. Unfortunately, however, in both of these years the fish-curers sustained very great losses. In 1884, in accordance with the usual custom, arrangements were entered into before the fishing began, under which the herrings taken during the season, whatever might be their size or quality, were to be bought by the curers from the fishermen at certain prices, with bounty money in addition. The fish-curing business had been in a prosperous condition during some of the immediately preceding years, and in consequence of this these prices and the bounties were very high.

Market glutted with Cured Herrings, and great fall in prices.

The fishing of 1884 was, as already stated, the most abundant ever known, and in that year the market became glutted with cured herrings, and a great fall in prices took place. The consequence was that the curers suffered heavy losses; and these losses were greater than they would otherwise have been, owing to an unusually large portion of the catch of that year having consisted

of small herrings, which the curers were often unable to dispose of at almost any price. Notwithstanding this unfortunate result, agreements were entered into for the catch of last year on terms somewhat similar to those made in 1884, with the exception that the bounties to be paid were smaller. But the herring fishing of 1885, being a very large one, and the markets being again greatly overstocked with cured herrings, prices continued very low, and a second time heavy losses were sustained by the curers. The history of this industry shows that successive years of prosperity have once and again been followed by one of an opposite character; but it does not appear that any past year ever proved so disastrous to those engaged in the trade as either of the last two; and it is certain that no two years, from which flowed such unfortunate results, ever came together before. It is much to be feared that this important branch of the fishing industry will greatly suffer for a considerable time to come, owing to a number of the curers not having sufficient capital left for its efficient prosecution.

Curers sustained heavy losses in two successive years.

Anticipated consequences as to Curing Industry.

Abundant supply and low prices of Herrings a boon to community.

On the other hand, the herring fishery of these last two years provided an abundant supply of wholesome and nutritious food, which was sold at a very low price, and thus a great boon was conferred on the community, especially on the poorer classes. This boon would have been much greater, had better means existed than were available for getting the fish rapidly and cheaply conveyed to towns throughout the country, particularly those which are inland and have a large population. And with reference to this, it is greatly to be regretted that large quantities of small herrings, which would have made excellent food if used either fresh or lightly salted, but which it was not profitable to cure, had, throughout the season, to be sold for manure, because no better means of disposing of them could be found. Indeed, it often happened that whole boat loads of them were thrown back into the sea.

Herrings returned to in-shore grounds.

A very striking feature of the summer herring fishery of 1885 was that many in-shore grounds, where herrings were found in great abundance in previous years, but which they had recently all but deserted, were restored to their former fertility. Speaking generally, these grounds lie from 1 to 8 miles from land in the districts of Eyemouth, Peterhead, Banff, Buckie, Findhorn, Cromarty, Helmsdale, Lybster, Wick, and Orkney; and it was in them, and in the Shetland district, where the best fishing of the season was got. Further, it is worthy of note that, at the close of the year, the in-shore grounds from Anstruther to Wick teemed with excellent herrings to a much greater extent than had ever been known before.

Increasing productiveness of Herring Fishery in Shetland.

The extraordinary increase of the herring fishery in the Shetland district in recent years has been fully adverted to in the Board's former Reports. The produce of last year's fishing was even greater than that of 1884, which was the largest ever recorded, and the herrings taken were of finer quality than those got on the other parts of the East Coast. Altogether, Shetland now takes rank as the most important herring fishery district in the country. Last year it yielded 370,238 barrels of cured herrings, as against 300,117 in 1884; while the number cured so recently as in 1874 was only 1100 barrels. It is gratifying to add that the great development of the herring fishery in Shetland has had a marked effect in

improving the condition of the people; and in no way does this more forcibly appear than by the small open boats which formerly belonged to the native fishermen being all but superseded by the large and fully equipped decked boats which they now possess.

With regard to the branding of herrings, it is of importance to state that, although the quantity of cured herrings exported in 1885 was less by 56,631 barrels than in 1884, the number of barrels branded last year, nearly the whole of which were sent abroad, was not only greater than in 1884, but exceeded the number branded in any former year whatever. The actual number so dealt with in 1885 was 689,325. The fee charged for branding is 4d. a barrel; so that the total amount received by the Board for this service last year was £11,488, 15s. As the taking of the brand is entirely optional on the part of curers, this increased demand for branded herrings is most gratifying to the Board, as showing the growing estimation in which the standard of cure required by them is held.

Number of barrels branded, greatest on record.

Proof of increasing estimation in which brand is held.

The gross quantity of the other sea fish landed and sold fresh in 1885 was very large, and exceeded in value the abundant catch of 1884 by £21,529. The fish especially which were taken in increased quantities were cod, ling, haddocks, whitings, and flat fish; and the gross weight of the whole catch in 1885 was 1,725,459 cwts., as against 1,494,042 cwts. in 1884. Of shell-fish, there was an increase in the quantity of lobsters taken in 1885, as against 1884, and a decrease in oysters, mussels, and crabs; but the value of all the shell-fish taken in 1885 was greater than in the preceding year by £8254. Thus the gross value of white fish taken and sold fresh in 1885, and of shell-fish, exceeded that of 1884 by £29,783.

Other sea fish landed greater than in previous year.

Increased value thereof.

During the fishing season of 1885, more than 3000 boxes of salmon in excess of 1884 were sent to London. But this was not equal to the exceptionally good year of 1883, which is the best that has occurred—taking the number of boxes of Scotch salmon sent to Billingsgate as a criterion—for the last 50 years, with the exception of 1835 and 1842. The number of boxes sent to London in these three years was, in 1883, 35,506; in 1884, 27,219; and in 1885, 30,362.

Salmon Fisheries more productive in 1885 than in 1884.

The closing weeks of the fishing season of 1885 were very dry on the East Coast, and the takes of salmon at the rivers' mouths, especially in the mouth of the Tay, were unusually large. At the three stations of Neilston, Monifieth, and Buddon, three tons of salmon, grilse, and trout were taken in the nets in four days; and in six days of the same month of August no fewer than 10,000 salmon and grilse were stated to have been caught at the fishings on the Forth and Tay, rented by Mr A. G. Anderson.

Particulars of takes of Salmon.

In a subsequent part of the Report it will be seen that the estimated value of the herrings which were cured last year was £1,572,952, 5s., and of those which were sold fresh £122,034, making together £1,694,986, 5s.; that the estimated value of other white fish was £751,792, 10s.; of shell fish, £89,193; and of salmon, £323,851; the gross total estimated value of the sea and salmon fisheries of Scotland for the year 1885 thus being £2,859,822, 15s.

Gross value of Sea and Salmon Fisheries.

Number of persons employed in Fisheries.

Number of Boats and Capital invested.

It will be further seen by this Report that the number of persons in Scotland who were employed in connection with the sea fisheries last year, and who, with their families, were more or less dependent upon them, was 102,134; that the number of fishing boats and vessels engaged was 15,532; and that the estimated amount of capital invested in boats and vessels, nets, and lines, was £1,828,446.

SCIENTIFIC INVESTIGATIONS.

Marine Stations of the Board.

In the Report for 1884, it was mentioned that the Board's Marine Laboratory at St Andrews had been completed and provided with many of the necessary appliances for studying the life-history of fishes and other marine forms. It was also mentioned that a temporary laboratory had been erected at Tarbert, in Loch Fyne, chiefly to admit of inquiries being made as to the rate of growth, migration and food of the Loch Fyne herring, and further that several tanks in the Rothesay aquarium had for some months been at the service of the scientific committee. During the summer and autumn the Tarbert and St Andrews Laboratories were utilised for various investigations, to be afterwards referred to, and during the winter the material collected was as far as possible worked up in the Natural History Department of the University of Edinburgh. Throughout the year the scientific committee of the Board has had the assistance of Mr Brook in organising and carrying on the investigations, and valuable assistance has also been rendered by Professor Stirling and Mr Duncan Matthews of Aberdeen, Professor M'Intosh of St Andrews, Professor Greenfield and Dr Gibson of the University of Edinburgh, the Rev. A. M. Norman, D.C.L. of Durham, and Mr Halliburton of University College, London.

Want of suitable Boats.

Although the Board had two laboratories sufficiently equipped to admit of several important inquiries being initiated, and the assistance and co-operation of the scientific men above mentioned, it was unfortunately unable to carry on the work in a satisfactory manner for want of suitable boats. The 'Jackal,' as pointed out in previous Reports, is not adapted for assisting in scientific work, and her tender 'Daisy' is, for want of steam power, practically useless. Throughout the year the limited amount of dredging and field work accomplished was rendered possible by boats provided by Professor Ewart. It is to be hoped that when the 'Jackal' is succeeded by the 'Woodcock,' arrangements will be made by the Admiralty that will admit of the superintending vessel undertaking a complete survey of the spawning banks, and assisting in work of a like nature when required. In America the 'Albatross' is under the command of an experienced officer, who superintends all the physical observations made, and furthers in every way in his power the biological work of the Fish Commission. As long as the Board have the use of a gunboat, maintained at great public expense, it will not be justified in asking for large sums of money to provide vessels for assisting in so thoroughly national work as examining the fishing banks along the western shores, and in facilitating other

long neglected and equally important investigations. In the meantime, it is even more important that a small steam tender should take the place of the 'Daisy.' It is extremely desirable to determine the migration of the Loch Fyne herring. This question has been long under consideration, and on it many other problems depend—problems which, at the present moment, force themselves to the front, owing to the agitation of the Loch Fyne and other fishermen, for a close time being enforced in the Firth of Clyde from January until May. For following the herring shoals, the 'Daisy' is as unfit as she is for superintendence, simply because, for want of steam, she is for days at a time unable to move from one part of Loch Fyne to another. While the boat service is unsatisfactory on the West Coast, it is right to add that a small steamer has been provided for the trawling experiments and other work which the Board is required to undertake on the East Coast.

Steam Tender wanted to take place of 'Daisy.'

On the West Coast, Rothesay aquarium was the chief centre of work during the spring. Some of the investigations made were referred to in the last Report. The spawning of the cod was studied by Professor Ewart and Mr Brook, who generally confirmed the observations of Sars, and gained further information as to the natural and artificial fertilisation of the eggs, and their buoyancy before and after fertilisation in different kinds of water. Mr Brook, by studying the spawning process in the whiting, was able to determine, as was expected, that the eggs behave in exactly the same manner as those of the cod. A large amount of material was collected for studying the development of the herring. A paper on this subject by Mr Brook will be found in the Appendix, page 31; and a more complete account of the early stages of the development of the herring was communicated, with the permission of the Board, to the Royal Society of Edinburgh.

Work at Rothesay Aquarium.

During the summer and autumn, the recently erected laboratory at Tarbert served for continuing the investigations. At Tarbert considerable attention was directed to the food of the herring. In order to throw light on this and other subjects, a collection was begun of the Loch Fyne fauna. A list of the forms already identified will be found in the Appendix (page 231). This list includes the fishes, mollusca, echinoderms, and several groups of the crustacea. The species in the list, which are known to serve as food for fishes, are marked with an asterisk, in order to indicate the forms available for food in Loch Fyne. Amongst the crustacea enumerated there is one (Siriella Brooki) new to science, and there are others which have not hitherto been recorded as British. A paper on the new and interesting crustacea, collected during the year, has been prepared by the Rev. Canon A. M. Norman (see Appendix, page 155). Several of these crustacea are of peculiar interest, owing to their forming the chief part of the food of the herring during a considerable portion of the year.

Work at Tarbert.

List of fauna of Loch Fyne

Another group of crustacea, the Copepoda group, also enters largely into the food of the herring, especially during the summer months A note of the copepods collected in Loch Fyne has been prepared by Mr Calderwood (see Appendix, page 147). Out of the twenty-seven species enumerated, seven have been found in the stomachs of herring captured on the West Coast.

Copepods of Loch Fyne.

The results of the information gained, as to the food of the herring in Loch Fyne during the summer and autumn, are incorporated in a paper referred to below.

Hatching of Herring in Deep Water.

Loch Fyne afforded an opportunity during the autumn for conducting an experiment as to whether herring ova are capable of developing in deep water. During recent years the great summer herring fishing has been prosecuted further and further from shore, and the average size of the fish captured has diminished so greatly that while in 1860 only, in round numbers, 170 of the 193,000 barrels branded were maties, there were 313,000 barrels of maties and only 220,000 barrels of full herrings branded in 1885. Some are inclined to believe the herring shoals are prevented from reaching the inshore spawning banks by the thousands of drift-nets, while others allege that herring eggs are incapable of developing in deep water, *i.e.*, on banks from 50 to 80 fathoms beneath the surface.

Professor Ewart, when on board H.M.S. 'Jackal,' attempted to ascertain whether spawn was deposited on the offshore banks by dredging. He was, however, unsuccessful, and instead of continuing the dredging in 1884 he deposited artificially fertilised eggs in deep water (104 fathoms) off Fraserburgh. Having failed in the Moray Firth, he next made arrangements for depositing eggs in a heavy slate tank in Loch Fyne during the summer of 1885. From this experiment (see Appendix, page 43), which was entirely successful, it was found that the only difference between the hatching of herring ova in deep and shallow water is one of time. The eggs deposited on deep offshore banks will hatch some days later than those deposited on shallow inshore banks. If the herring which formerly spawned on the inshore banks of the Moray Firth in from 10 to 20 fathoms now spawn offshore in from 40 to 60 fathoms water, hatching will be delayed for several days, and maturity will not be reached as early as formerly. This may be deemed an argument in favour of beginning the herring fishing later, instead of earlier, than in former years.

Loch Fyne Herring Fishing.

During the summer and autumn, the migration, rate of growth, and time of spawning of the Loch Fyne herring were studied as far as practicable. These and other questions are referred to in a paper by Mr Brook (Appendix 47). It seems many of the Loch Fyne fishermen believe that the herring migrate backwards and forwards between Loch Fyne and Ballantrae, leaving Loch Fyne in the autumn, to return again in the spring. During 1885 the herring are said to have reached Loch Fyne earlier than usual, and to have, to a great extent, left in August and September instead of October and November.

On reaching Loch Fyne the herring are chiefly in a spent condition, but they rapidly improve by feeding extensively on the immense shoals of copepods found in the surface waters.

Food of Loch Fyne Herring.

The most important species of copepod is *Calanus finmarchicus*, which, during the summer, is charged with rich oil globules, that render this species particularly nourishing as food. The superior quality of the Loch Fyne herring is probably due to the richness of the copepods on which they feed. Many of the herring increase considerably in length during the months of May, June, and July,

and in August they nearly reach maturity. Last autumn the majority of the herring seem to have left Loch Fyne in August to spawn in the Sound of Kilbrannan during the months of September and October. One or two shoals seem to have passed southwards by way of the Sound of Bute towards the Ayrshire Coast. From a comparison of the statistics given for the past twenty years of the fish caught in Loch Fyne and in the Sound of Kilbrannan, it will be seen that the latter district has almost entirely supplanted Upper Loch Fyne as a spawning ground for the herring.

Migration Loch Fyne Herring.

The Loch Fyne fishermen have, for several years, been agitating that the herring fishing on the South-west Coast should be placed under certain legislative restrictions. Further investigations are necessary ere the migration of the Loch Fyne herring can be made out and the question of a further close time considered.

Workers at the Tarbert Station.

During the year the following gentlemen took advantage of the Tarbert laboratory:—Professor D'Arcy Thompson of University College, Dundee; Sims Woodhead, Esq., M.D. of the University of Edinburgh; and James Murie, Esq., M.D. of the Linnæan Society, London, who rendered valuable assistance in arranging and classifying the material collected in Loch Fyne. During the winter the laboratory has been under the charge of Mr Thomas Scott, who has made a collection of the crustacea, &c., which serve as food for the herring and other useful fishes.

Varieties of the Herring.

In the Report for 1883 Professor Ewart called attention to the fact that the German Commission had arrived at the conclusion that the Baltic herring differed sufficiently from the North Sea herring to be worthy of being considered a special variety. It has long been held by fishermen and others that each district has its own peculiar variety. From some 500 specimens examined in 1833 no evidence of the existence of such varieties was found. In order to settle this question finally, Mr Duncan Matthews has been examining for a considerable time samples of the herring captured around the Scottish Coast. An important paper on this subject will be found in the Appendix (page 61).

The method of investigation adopted was to take accurate measurements of the length of the head and of the caudal, dorsal, and anal fins, to note the position of the fins on the body, &c., and by a comparison of these data with the length of the body to ascertain the amount of their actual variation, and especially whether these variations were so constant in the herrings of any one or more localities or seasons as to indicate a distinction of races.

From this inquiry it seems that there are as large herring now as there were some generations ago, and that although each district yields large herring, the North-East Coast has a slight advantage in this respect over the South-East and West Coasts. A table giving the size, &c., of the largest fish examined includes representatives from every fishery district, and shows that there is no practical difference in size between the male and female, nor in the numbers of each of these which were taken.

The winter fish are found to be rather larger than those taken in summer, while among the fish commercially termed 'maties,' there are (1) immature herring, *i.e.*, herring which, in addition to being small in size, have undeveloped milts or roes; (2) small

Varieties of the Herring.

herring in all degrees of ripeness up to maturity; (3) small herring which have spawned—small 'spent' herring. Hitherto the size of the fish, rather than the sexual condition, has apparently determined whether the term 'matie' should be applied. In the same districts, and even in the same shoals, *large* sexually immature herrings are often found along with *small* ripe or nearly ripe herring, hence herring appear not only to vary in size in their fully adult condition but also to vary in the size at which they reach sexual maturity. It is pointed out that these results, as well as the fact that the undivided ova vary in size in ratio to the size of the fish, are likely to cause considerable variation in the progeny, which result from the interbreeding of fish of varying *size* and age. Of the fish caught in the early part of the season a much larger proportion are immature and small, and probably also younger than is the case later on. The adult fish appear to reach a more advanced stage of ripeness before they approach the spawning banks.

From the measurements made it is shown that the length of the head varies considerably, the extremes being found in herrings, of all localities and both seasons, the percentage with the larger size of head being rather greater among the winter than the summer herring; but this difference, like that of the total length, is considered insufficient to prove a racial distinction.

The position of the centre of the dorsal fin, in a majority of the winter herrings, is anterior to the centre of the body, whereas among the summer herrings a large percentage have it behind the centre. In the immature fish, however, the fin centre is generally anterior to the body centre.

The anal and pelvic fins show a corresponding difference in position. As regards the pelvic fin, however, this condition is limited to the adult and larger young herring, the pelvic fin being found, like that of the sprat, anterior to the dorsal fin in young herring below 60 mm. in length.

The pectoral fin varies very slightly in its relative position on the winter and summer herring.

The relative basal length of both the dorsal and anal fins conveys no indication of racial distinction between the summer and winter fish. The dorsal fin is in all the herrings generally longer than the anal, only about 1½ per cent. of the summer herrings and 7½ of the winter having the anal fin longer than the dorsal. Further details are given respecting the number of fin rays, keeled scales, circumstances of spawning, &c., but which scarcely affect the question of racial distinction. The inquiry, so far as it has gone, tends to prove that there is no racial distinction between the herrings found in the various localities around the Scottish coast. Judging, however, from the more backward position of the dorsal pelvic and anal fins, the doubtfully smaller head, and the slightly lesser size of the summer herrings, more minute inquiries may indicate a slight difference between the winter and summer herrings.

The Board have already expressed regret that so many tons of sprats are annually used as manure. Were it possible to transmit sprats at a reasonable rate to the large centres of population, they might form an exceedingly cheap and valuable addition to the

food supply of both rich and poor. But even where this is not possible they might be economically used. It has been pointed out that at Eide, in the Hardanger Fjord, Norway, they are extensively preserved as anchovies, while in Canada they are cured as sardines. It is to be hoped that ere long, if not used fresh or preserved, nutritive extracts, oils, glues, and other valuable products, will be prepared from them before they reach the manure factory, for until the oils are extracted, their fertilising power is exceedingly limited.

Nature of Whitebait.

A question of almost equal interest is the supply of whitebait. From investigations made by Professor Ewart and Mr Matthews, it seems that whitebait consists almost entirely and at all seasons of young sprats and young herrings, which vary in size and in the relative proportions according to the season of the year and the place of capture. From the samples examined it appears that during the winter and spring months sprats largely predominate. In the Firth of Forth whitebait there are very few young herring, while in the winter whitebait found in the London markets herring only form about 6 per cent., the remainder being sprats. As the season advances the London whitebait contains a larger number of herrings, there being during June and the latter part of May nearly 80 per cent. In July the number of herrings slightly diminish, and in August whitebait is composed of about one half herrings and one half sprats. A reference to the paper (Appendix, p. 96) shows further that the size varies considerably during the year.

This being the case the Firth of Forth and other inshore waters might, in addition to providing whitebait for the towns in their vicinity, send consignments to the English markets during the winter and spring months. Hitherto most of the whitebait used in Scotland has been obtained from London.

Food of the useful Fishes.

As already indicated, the material collected by the Fishery officers on the West Coast was, as far as possible, examined in the Natural History Department of the University of Edinburgh during the winter. Part of this work consisted in continuing the examination of the food of the useful fishes, and those papers dealing with the food of the herring, cod, and haddock will be found in the Appendix. From the paper on the food of the herring by Mr Brook and Mr Calderwood, it will be seen that several thousand stomachs were examined, which represented the chief fishing stations around the coast.

Food of the Herring.

It seems the food of the herring, which differs very considerably at different seasons and in different districts, consists of various kinds of free swimming crustacea, most of which are minute, while others measure an inch or more in length. During winter and spring herring feed chiefly on *Hyperia Galba, Nyctiphanes norvegica, and Sagitta.* Sprats constitute a large part of the food at certain seasons in such areas as the Firth of Tay and the Beauly Firth. Near the Island of May during the spring fishing the herring feed largely on the ova and young of their own kind. During the summer the East Coast herring feed on copepods, but apparently do not take large quantities of food at this season. On the West Coast the copepods supply the chief portion of the herrings' food, while *Hyperia* has not been met with, and

Nyctiphanes does not play as important a part as on the East Coast. In Loch Fyne the herring feed almost entirely on copepods during the summer months, and it is not until the autumn that other crustacea are taken to any great extent.

The scientific committee, in addition to continuing their observations as to the food of the herring, has directed their attention to the food of the haddock and cod.

The food of the haddock as far as determined (see paper, Appendix, p. 128), consists chiefly of echinoderms, crustacea, and annelids.

Food of the Haddock.

The echinoderms take the first place, the brittle-star and the pea-urchin being most frequent. The crustacea come next in importance, and are represented by the hermit crabs, squat lobsters, spider crabs, and several species of the shrimp tribe. All these are found in abundance along the East Coast. The mollusca found varied considerably, but were in most cases young specimens. The annelids were represented chiefly by the sea-mouse (*aphrodite*) and other free forms.

The haddock does not appear to feed to any great extent on other fishes, and in this respect differs in a marked degree from the cod; like the cod, however, when herring spawn is abundant, they congregate on the banks and feed almost entirely on spawn.

Food of the Cod.

It appears that the food of the cod (Appendix p. 134) differs considerably from that taken by its ally the haddock. The echinoderms which play such an important part in the haddocks' food do not appear to enter largely into that of the cod, which seems to depend chiefly on the crustacea, flat fishes, and members of its own family—whiting, haddock, &c. The sea-mouse also constitutes a very important part of the food during the spring and summer, in districts where this form is plentiful. In the winter the cod is attracted to our shores by the large shoals of herring which arrive to spawn on the inshore banks, and at this time herring and herring ova form the staple food. From the evidence brought forward it does not appear that the cod feeds largely on herring at other times.

Fish as Food.

Turning from the food of fishes to the consideration of fishes as food, the Board regret having to confirm the belief that fish are not appreciated amongst the working classes as much as they ought to be. The prejudice against fish has arisen it seems because a fish diet is not supposed to be capable of supporting sustained manual labour. The muscles of fish undoubtedly differ in structure and chemical composition from the muscles of the higher vertebrates. With a view of pointing out these differences, and indicating how a fish diet may be prepared to meet the wants of those engaged in outdoor as well as indoor work, the Board hopes to have several inquiries instituted. As a first instalment a paper will be found in the Appendix (p. 166) by Professor Stirling of the Victoria University, Manchester. Dr Stirling describes the distribution arrangement and histological structure of the red and pale muscles in some of the common fishes. These two kinds of muscles are known to exist in some mammals, insects, and other animals, but their extensive distribution in fishes is an important point in relation to the origin of muscular tissue. Besides other differences,

Structure of the Flesh of Fish.

Dr Stirling finds that the red or coloured muscles in some fishes, *e.g.*, mackerel, contain numerous fatty granules in their sarcous substance, while the pale muscles are devoid of such fatty granules.

Bye-products of the Fisheries.

The importance of utilising the bye-products of the fisheries is now widely recognised. Professor Ewart, in his paper on the progress of fish culture in America, which appeared in our last Report, mentioned that the oils, glues, fertilising agents, &c., prepared from the refuse of the fisheries of the United States, realised 14 per cent. of the total value of the fish captured. Scotland has hitherto done little to utilise either the refuse which results from the fish cured or the large numbers of fish of various kinds, which owing to low prices or unsatisfactory modes of transit, never reach the great fresh fish markets. Recently, however, as the results of experiments made on a fairly large scale in Aberdeen by Mr Sahlström, arrangements are likely to be made which will, it is hoped, lead to the present harvest of the sea yielding not only a considerably larger amount of food but also a large number of exceedingly useful products. A paper bearing on this subject by Professor Stirling will be found in the Appendix (p. 256). In this paper Dr Stirling gives an account of certain economical products obtainable from fish, *e.g.*, glue in various forms, fish extracts from the flesh of fish, mollusca and crustacea, and from whales and other large marine animals; oil from the liver; bone earth, and manure from the refuse. The great point is that many products suitable for food, or for economical purposes, can be obtained from fish and other marine animals were suitable factories established on the sea-coast near those parts where fish can be caught in abundance, but whence removal of the fish in a perfectly fresh condition cannot be effected, either so expeditiously or so profitably as to make the matter commercially successful.

Blood of the Norway Lobster.

There is another paper bearing on the same subject in the Appendix (p. 171) by Mr Halliburton, who gives an account of the blood of the Norway lobster (*Nephrops*) so abundant in our waters. The blood of the higher vertebrates has long been used for the manufacture of albumen, which has a high market value. Recent inquiries show that equally good albumen can be obtained from the blood of fishes, and it may be further shown that the blood of *Nephrops* (of which there is relatively a large quantity) and other invertebrates may be utilised in the same way.

Fungi, &c., in Salmon rivers.

In the Board's last Report it was mentioned that Professor Greenfield had undertaken to investigate the lower fungi met with in some of our more important salmon rivers. This investigation has been advanced a step, and numerous forms have been isolated and cultivated by the methods already described.

An account of the observations already made will be found in Appendix, p. 176.

The samples of water examined were taken from the Tweed and Tay during the months of March and April.

The number of organisms in Tweed water was found to exceed that which should be present in good potable water. Professor Greenfield also describes the naked-eye forms of growth and microscopic appearance of many of the minute organisms isolated.

It is proposed to continue this series of investigations in order to obtain more accurate information as to the number and variety of these lower fungi in our rivers and their relation to the amount of dead organic matter present in these waters. It is also proposed to attempt to trace the relation between the conditions under which these lower fungi exist, and those favourable to the development of the salmon fungus.

Physical Observations made in Moray Firth.

In the Board's Report for 1883 reference was made to the preliminary inquiries made during the autumn of that year in the Moray Firth. Part of this work consisted in collecting samples of water and in taking the surface and bottom temperatures of the water at various parts of the firth. Considerable time was required by Mr John Gibson, Ph.D. (who was good enough to undertake the physical work of the expedition), to examine the samples of water collected and to tabulate the results. A report of this work will be found in the Appendix (p. 89). It contains a brief account of the collection of the samples of sea-water, and tables of the specific gravities of these samples as obtained by a method which gives results of a higher degree of accuracy than has hitherto been attained in similar work, and which results are all strictly and directly comparable with each other, a point of the greatest importance. The chief value of the report lies in the full description of the method and in the proof of its special advantages. The question as to the relation between the density of sea-water and the amount of chlorine which it contains is also discussed, and tables are given showing the relation actually observed in the case of a number of the collected samples.

These two data, viz., the density and the relation of chlorine to density, lie at the root of our present knowledge of the chemistry and physics of sea-water. The elaboration of the above mentioned method has therefore paved the way for the future systematic work necessary to the attainment of that accurate knowledge of the various physical and chemical conditions obtaining in sea-water generally, and in our coast and river waters in particular, which is an indispensable preliminary to the clearing up of many of the practical and scientific problems now pressing for solution.

St Andrews Station.

Professor M'Intosh contributes an account of the work undertaken at the St Andrews Marine Laboratory since the issue of the last Report (see Appendix, p. 201). It includes notes on the mode of capture of food-fishes by liners and of the injuries which occur to baited hooks and to fishes on the lines. An account is also given of two kinds of fishing (viz., shrimp trawling and sprat fishing) in which many immature fish are captured.

An examination has been made of a large number of important fishes, including a fine specimen of the Tunny, captured by the General Steam Trawling Company, in October last. Professor M'Intosh also gives an account of the eggs and young of a number of fishes which have been studied during the past year. An opportunity has also been afforded of studying the effect of storms on the marine fauna in St Andrew's Bay. The report likewise includes a note on the structure of the tail of *Myxine glutinosa* by Professor Cleland, F.R.S., of Glasgow.

Recently considerable attention has been devoted by Mr Wilson

Life-history of the Mussel.

to the development of the common mussel, and an account of his investigations up to the present time will be found in the Appendix (see page 218). During the summer and early autumn several attempts were made to fertilise the eggs artificially at St Andrews. The early stages of development were studied from ova obtained in this manner, while the free swimming embryos were frequently obtained in pools amongst the mussel beds in the Eden and in other localities.

As the supply of bait is a matter of great importance to the fishermen, the inquiry as to the life-history and growth of the mussel will be continued. In addition to this and other work, arrangements will be made for utilising the St Andrew's laboratory to the fullest extent in connection with the trawling experiments likely soon to be begun in St Andrew's Bay.

Naturalists and fishermen alike have long felt the absence of accurate information as to the spawning period of fishes.

Spawning period of Fishes.

In order to have a basis on which to found further investigations, Mr Brook has prepared a provisional list of the spawning period of the various food fishes. This list brings out the great lack of accurate information on the subject; but gives an idea of the opinions as to the spawning periods held by fishermen and others around our coast. These opinions are in many cases conflicting, and in most cases they will require to be altered. The dates, which are given in bolder type, have already been verified.

Notes on rare Fishes.

Under the title of 'Ichthyological notes,' Mr Brook has given a short account of the rare fishes that have been met with during the year. The most interesting of these is *Zeugopterus unimaculatus*, a small flat fish allied to the turbot. It was taken on several occasions in Loch Fyne and kept alive for several months in the Tarbert Laboratory, where its habits and mode of respiration were carefully studied. Notes are also given of the occurrence of twelve other species which are more or less rare around our coasts. These include *Ctenolabrus rupestris, Centrolabrus exoletus, Motella cimbria, Zeugopterus punctatus, Pristiurus melanostomus.*

In addition to the above, a note will be found on two specimens of the Greenland shark (*Læmargus microcephalus*) by Mr Calderwood.*

AMENDMENT OF THE LAW RELATING TO SCOTTISH SEA FISHERIES.

Report of Trawling Commission.

The Royal Commissioners appointed in 1883, of whom your Lordship was chairman, to inquire and report upon the complaints that had been made by line and drift-net fishermen of injuries sustained by them in their calling owing to the use of the trawl net and beam trawl, in the territorial waters of the United Kingdom, issued their Report in 1885. In consequence of conclusions which the Commissioners came to, and of facts brought before them in the course of

Recommendations relating to Scottish Sea Fisheries:—

* A report on the hatching of cod, haddock, and other white fish, and on the hatching and rearing of lobsters in Norway, and a report on the relations of the size of the herring captured on the East Coast to the size of the mesh of the nets used, which have not been included in this Report, will, along with other papers, be presented at an early date.

their inquiry, they submitted a number of recommendations to Her Majesty, of which the following relate to the sea fisheries of Scotland:—

Scientific Experiments and Fishery Statistics.

'That a central authority be created to supervise and control the 'fisheries of Great Britain, if not of the United Kingdom, and that 'a sum of money be annually granted to such authority for the 'purpose of conducting scientific experiments and for collecting 'fishery statistics.

Closing Waters against any mode of Fishing.

'That in the meantime powers be given to the Scotch Fishery 'Board similar to those of the Irish Board, enabling them to make 'bye-laws for the regulation or suspension of beam trawling, or of 'any other mode of fishing within territorial waters; and that a 'sum of money be granted annually by the Treasury for the pur-'poses mentioned in the last paragraph.

'That statutory powers and means be given to the fishery autho-'rities to enable them to collect adequate statistics.

Efficient Steam Vessels to be provided.

'That the cruisers serving under the Scotch Fishery Board, 'whether employed for police or scientific purposes, be replaced 'by efficient steam vessels.

Numbering and Lettering of Trawlers.

'That steam trawlers, besides having their number and letters 'painted on the bow, should also have them painted on the 'quarter.

Provisions of Law to be made known.

'That printed notices, stating concisely the provisions of the law 'relating to the fishing industry, together with instructions to fisher-'men how to proceed in cases of injury to gear, be posted up in 'every fishing port.

Power of Boards' Officers when damage is done to Fishing Boats.

'That in all cases of damage to a sea-fishing boat, where the 'amount claimed is less than £10, a fishery officer, on complaint 'verbal or otherwise made to him, and after proof that reasonable 'notice of the complaint has been given to the party charged, 'should be entitled to award compensation whether the party 'charged appear or not. That, whether an appearance be entered 'or not, the amount of compensation awarded should be embodied 'in a certificate signed by the officer, in virtue of which the com-'plainant should be entitled to recover the amount certified before 'a Small Debt Court in Scotland.

Admiralty to maintain efficient Sea Police.

'That arrangements be made with the Admiralty for the mainte-'nance of an efficient sea-police at all times. Efficient steam 'vessels should be employed as fishery cruisers under the fishery 'authorities, and the number of vessels employed on this service 'should be sufficient, with assistance from the ships of the Royal 'Navy at certain seasons of the year, to ensure the adequate per-'formance of police duties and the preservation of order among the 'various classes of fishermen round the coasts of the United 'Kingdom.'

Sea Fisheries (Scotland) Amendment Act.

Bye-laws for Closing Waters against any mode of Fishing.

Lettering and Numbering of Boats.

The above-mentioned Report was presented to Parliament in March last year, and, in August following, the Sea Fisheries (Scotland) Amendment Act, 1885, was passed empowering the Board to make bye-laws for restricting or prohibiting any mode of fishing in any part of the sea adjoining Scotland, and within the exclusive fishery limits of the British Islands; to enforce the laws as to the numbering and lettering of fishing-boats, includ-

ing steam fishing-boats, as to which new regulations were made; and to require all persons belonging to British sea-fishing boats, and fishcurers, catching or curing sea fish in Scotland, or in any part of the sea adjoining Scotland, to make returns, in such form and at such periods as the Board may prescribe with the sanction of the Secretary for Scotland, of all sea fish caught or cured by them respectively. Certain powers were also conferred upon the officers of the Board relative to the settlement of questions of damage done by one sea-fishing boat to another, or the nets, lines, gear, or other fishing apparatus thereof; and the Board were authorised to make regulations concerning the hooping of barrels. They were also invested with all the powers and duties of the Board of Trade, so far as they can be exercised in Scotland, with respect to the oyster, crab, lobster, and mussel fisheries, and clam and bait beds.

Returns of Fish caught or cured.

Damage to fishing boats.

Hooping of Barrels.

Shell Fisheries and Bait Beds.

The proceedings which the Board have taken under this Act of Parliament, will be stated in subsequent parts of the Report.

BYE-LAW MADE BY THE BOARD TO PREVENT BEAM TRAWLING IN CERTAIN IN-SHORE WATERS.

As already stated, the Royal Commissioners who were appointed in 1883 to inquire and report upon the complaints made by line and drift-net fishermen of injuries sustained by them owing to the use of the beam trawl net in the territorial waters, recommended that powers should be given to this Board to make bye-laws for the regulation or suspension of beam trawling, or of any other mode of fishing, within any part of the territorial waters adjoining Scotland; and that shortly after the Commissioners' Report was presented to Parliament, the Sea Fisheries (Scotland) Amendment Act, 1885, which conferred upon the Board such powers, was passed. In the fourth section of that Act it is provided that:—

Commissioners recommend that Board get powers to close Territorial Waters.

Act passed conferring such powers.

When the Fishery Board for Scotland are satisfied that any mode of fishing in any part of the sea adjoining Scotland, and within the exclusive fishery limits of the British Islands, is injurious to any kind of sea fishing within that part, or where it appears to the Fishery Board desirable to make experiments or observations with the view of ascertaining whether any particular mode of fishing is injurious, or for the purposes of fish culture or experiments in fish culture, the Fishery Board may make bye-laws for restricting or prohibiting, either entirely or subject to such regulations as may be provided by the bye-law, any method of fishing for sea fish within the said part, during such time or times as they think fit, and may from time to time make bye-laws for altering or revoking any such bye-laws.

Provisions of the Act.

A bye-law under this Act shall not be of any validity until it is confirmed by the Secretary for Scotland.

A bye-law shall not be confirmed until the expiration of one month after notice of the intention to apply for its confirmation has been given by the Fishery Board by advertisement in one or more newspapers circulating in the county or counties adjoining the part of the sea to which such bye-law applies.

The Secretary for Scotland shall allow any person to make a representation for his interest against the confirmation of any bye-law, on a notice of objection being given by such person to the Fishery Board within the said period of one month, and may, if he see fit, allow parties to be heard thereon.

Decision of Board as to Waters to be closed.

Although the Board had previously given full and anxious consideration as to what in-shore waters ought to be closed against beam trawling, they deemed it right, when the Act was passed, in view of the important interests at stake, again to consider the whole matter. After having done this, they were fully confirmed in the conclusions at which they had formerly arrived, and accordingly they made the following bye-law:—

Bye-law made giving effect thereto.

Bye-Law made by the Fishery Board for Scotland under the Powers Conferred on the Board by the Sea Fisheries (Scotland) Amendment Act, 1885.

I. This Bye-law shall extend and apply to—

(1.) The Firth of Forth inside or to the west of a straight line drawn from Tantallon Castle on the south shore of the Firth to the Lighthouse on the Isle of May, and thence to Fife Ness.

(2.) St Andrews Bay and the Firth of Tay, so far as they lie inside or to the west of a straight line drawn from Fife Ness to the Fairway Buoy at the mouth of the Tay, and thence to the land.

(3.) That part of the sea of the coast of Aberdeenshire and Kincardineshire which lies inside or to the west of a straight line drawn from the Cruden Scars Rocks to a point one and a half miles east magnetic of Girdleness Lighthouse.

II. Within the foresaid limits no person, unless in the service of the Fishery Board for Scotland, shall at any time from the date when this bye-law comes into force use any beam trawl for taking sea fish; and the master or the person actually in command of any vessel acting in contravention of this bye-law shall, on conviction, be liable to a fine not exceeding £100, and failing immediate payment of the fine, to imprisonment for a period not exceeding sixty days, without prejudice to diligence by poinding or imprisonment, if no imprisonment has followed on the conviction—all in terms of the said Act.

III. This Bye-law shall come into force on Monday, the 5th of April next.

By order,

DUGALD GRAHAM, Secretary.

Dated at Edinburgh this 1st day of February 1886.

Grounds for making Bye-law.

It will be seen that the Board, under the provisions of the Statute, are empowered to make such a bye-law as this, on their being satisfied that 'any mode of fishing is injurious to any 'kind of sea 'fishing' within the waters to be closed, or where it appears to them 'desirable to make experiments or observations with the view of 'ascertaining whether any particular mode of fishing is injurious.'

The bye-law was passed, not because the Board felt satisfied that trawling was injuring any kind of sea fishing (in the absence of reliable statistics it was impossible to arrive at any conclusion on this question), but rather because, as recorded in their minutes, it is 'desirable to make experiments or observations with the view 'of ascertaining whether beam trawling is an injurious mode of fish-'ing.'

Reasons for closing areas selected.

A reference to the map will show that the three areas which are to be closed differ considerably from each other; and the Board feel satisfied that, in order to make their observations of any real value, experiments must be carried on in three such areas. The Firth of Forth is practically an inland sea; St Andrews Bay is in free communication with the North Sea; and this is still more the case with Aberdeen Bay. Unless the Firth of Forth is closed as far east as the line fixed in the bye-law, the number of fish in the inner waters of the Firth would not have a chance of increasing. Nearly the whole of St Andrews Bay has been closed, and only the inner part of the Aberdeen Bay, in order that a comparison may be made between the protected and unprotected parts of Aberdeen Bay and the corresponding parts of St Andrews Bay.

From the Report of the Trawling Commission and other sources, the Board are satisfied that for some time past comparatively little trawling has been carried on in the Firth of Forth. This being the case, the fish supply will not be materially diminished by these waters being closed to trawlers.

Parties make representations for their interest.

After the bye-law was made, the Board gave notice, in terms of the statute, that they intended to apply to the Secretary for Scotland for its confirmation. Thereafter, a number of persons made representations to the Board for their interests as affected by it. The General Steam Fishing Company (Limited), Granton, objected to its being confirmed; a number of the fishermen on the East Coast wished it confirmed as it stood; others of them desired that the limits of the waters to be closed should be extended; while others made representations as to their respective interests. The whole of these communications were forwarded to Mr Trevelyan, who was then Secretary for Scotland, and intimation was afterwards given to the persons that your Lordship, who had succeeded Mr Trevelyan, would hear them on the subject at the Scottish Office, Whitehall, on 5th April last. At this meeting there were with your Lordship the Lord Advocate, Mr Marjoribanks, M.P., who was a member of the Trawling Commission, and Sir Francis Sandford, Permanent Secretary of the Scottish Department. There were also present Mr Asher, M.P., Solicitor-General for Scotland; Sir Robert Anstruther, M.P.; Mr Preston Bruce, M.P.; Mr Barclay, M.P.; Mr Jacks, M.P.; Sir G. Campbell, M.P.; Mr Hunter, M.P.; Mr Finlay, M.P.; Mr Esslemont, M.P.; Mr Stephen Mason, M.P.; Dr R. Macdonald, M.P.; Mr M'Donald Cameron, M.P.; and Mr Haldane, M.P. The General Steam Fishing Company (Limited), Granton, was represented by Mr Adam Darling, director, Mr James Scott, manager, and Mr James M'Caul, secretary; and the line fishing industry by a large number of fishermen from all parts of the East Coast of Scotland. The Newhaven fishermen were represented

Meeting with Secretary for Scotland at which they are heard.

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by Mr T. D. Brodie, W.S., Edinburgh, Mr James Flockhart, and Mr William Merrilees; the Cellardyke fishermen by Mr J. Ritchie Welch, solicitor, St Andrews, and Mr James Smith; the Pittenweem fishermen by Messrs James Hughes, James Gray, and J. G. Mitchell; St Monance by Messrs David Duncan and William Kinnear; Fisherrow by Messrs Alexander Caird and Walter Banks; Prestonpans by Mr George Ross; Cockenzie by Messrs John Dickson and William Johnstone; Broughty Ferry by Mr Peter Sim; Buckhaven by Messrs Thomas Hutchison and Walter Deas. The deputations were introduced by Sir Robert Anstruther, M.P. At the interview representatives of those present were heard at considerable length as to their respective interests.

Statement on behalf of Fishery Board.

Sir Thomas J. Boyd, chairman of this Board, and Professor Ewart, convener of their Scientific Investigation Committee, attended the meeting on behalf of the Board. They stated that they saw no reason in the circumstances of the case why the decision of the Board making the bye-law should be altered, and asked that it should be confirmed. Professor Ewart then explained the nature of the experiments which were the reason of its being made. He said that it was impossible for the Board to say at present whether the areas specified were sufficiently extensive or not. They must make some investigations before even that question could be settled. If, after having made some inquiries in St Andrews Bay, they believed the line should be extended, he had no doubt the Board would be prepared to do so, but he held that they ought at the outset only to enclose such waters as were required for their experiments.

Secretary for Scotland very carefully to consider all that had been said.

Thereafter your Lordship summed up the arguments used on both sides, in order, as you said, to make sure that you thoroughly understood them; and you then informed those present that you would very carefully consider all that had been said before coming to any conclusion. The interview, which lasted nearly two hours and a half, was brought to a close with a vote of thanks to your Lordship for receiving the deputations.

Bye-law confirmed.

The result was that you confirmed the bye-law on 8th April last in the terms framed by the Board.

The Board, in order to be in a position to undertake the experiments referred to, in the event of the bye-law being confirmed, applied to the Lords of the Treasury for funds to enable them to purchase a small vessel for trawling and provide the requisite appliances and assistance. In response to this application, the Treasury agreed to place a sum of money on the estimates to be laid before Parliament which, in addition to paying for a steam tender, will admit of the operations being carried on throughout at least the first half of the present financial year. With part of this money the Board have purchased a small steam vessel (the 'Garland') which, as soon as fitted out as a trawler, will be utilised for making a systematic examination of the enclosed waters. This work will in great part consist in trawling along certain fixed lines in the several areas at stated intervals throughout the year. On each occasion, the contents of the trawl-net will be carefully noted, so that the takes may be compared from month to month, and from year to

year, both while the bye-law is in force and after its repeal. In addition to this trawling work, if sufficient funds are provided, observations will be made as to the abundance of eggs and young fish at various depths throughout the year; the influence which the presence of crustacea and other forms has on the number of food fishes at any given time; and further, large numbers of artificially hatched fish will be introduced into the enclosed areas to ascertain whether the yield of the in-shore waters can be increased, and also if it is possible to determine when the more important food fishes reach maturity.

HERRING FISHERY.

The Herring Fishery of 1885 was, with the single exception of 1884, the most abundant ever known. The following statement shows the quantity of herrings cured in each of the last six years:—

Barrels cured in last six years.

Years.	Barrels cured.
1880, ...	1,473,600¼
1881, ...	1,111,155¼
1882, ...	1,282,973½
1883, ...	1,269,412½
1884, ...	1,697,077¼
1885, ...	1,572,952¼

Decrease in 1885 from 1884.

These returns show that the number of barrels cured in 1885 was 124,125 less than 1884, or 7·89 per cent; but that it was greater than the average number cured in the preceding five years by 206,108½ barrels, or 15·07 per cent. The deficiency in 1885, as against 1884, was wholly caused by a decrease in the number of barrels cured on the East Coast of 137,068¼. On the West Coast there was an increase of 12,943¼ barrels, by which the deficiency on the gross number cured in the year was reduced to 124,125 barrels as stated above.

Increase on average of five years.

Decrease on East Coast, but increase on West Coast.

Results of 1884 and 1885 compared.

The particulars of the results of the fishing of last year, when compared with those of 1884, in the herrings cured, branded, and exported, and in the amount of brand fees received, are as follow:—

Years.	Barrels Cured.	Barrels Branded.	Barrels Exported.	Brand Fees.
1884, ...	1,697,077¼	653,425	1,185,220½	£10,890 8 4
1885, ...	1,572,952¼	689,325	1,128,589½	11,488 15 0
Increase in 1885,	...	35,900	...	£598 6 8
Decrease in 1885,	124,125	...	56,631	...

Increase in 1885 on average of preceding ten years.

A comparison of the results of 1885 with the average of those of the preceding ten years, shows a large increase in all the items, viz.:—

Years.	Barrels Cured.	Barrels Branded.	Barrels Exported.	Brand Fees.
Average of ten years, 1875–1884, .	1,097,067¾	474,409½	745,596	£7,906 16 6
Year 1885, .	1,572,952¼	689,325	1,128,589½	11,488 15 0
Increase in 1885, .	475,884½	214,915½	382,993½	£3,581 18 6

WEATHER AND DISASTERS AT SEA.

Importance of Weather.

Nothing affects the regular prosecution of the fishing industry more than the state of the weather. During 1885 the weather was, upon the whole, fairly suitable for fishing, and it may be regarded in this respect as having been equal to the average of former seasons. There were occasional fogs and calms, but the fishing was never interrupted, further than that the boats were sometimes delayed in getting to and from the distant fishing grounds. Fortunately, there were only two violent gales during the season when the herring fishing was general. The more severe one came on quite suddenly on the night of the 12th August, and blew with greater or less violence over the whole East Coast till the 14th. It is deeply to be regretted that this storm caused serious loss both of life and property. Three large boats foundered at sea off the coast of Aberdeenshire, and their whole crews were drowned. A number of other boats were wrecked or damaged; and the quantity of netting which was lost or destroyed was so great that fishing operations were much retarded, and indeed at some of the stations they were crippled for the rest of the season. The other gale took place in the second week of September, but, happily, it was not attended with such disastrous consequences. A great many nets, however, were either lost or damaged, but by this time the fishing at most of the stations had closed for the season.

Occasional Fogs and Calms.

Two violent Gales.

Loss of Life and Property.

126 Persons drowned.

It is the painful duty of the Board to record that, during the year 1885, no fewer than 126 persons connected with the Scottish Fisheries were drowned at sea—82 on the East Coast, and 44 on the West Coast. In the preceding year, the number of lives lost was considerably smaller, having been altogether 73 on both coasts. Further, in 1885, 51 boats, valued at £14,764, were totally wrecked, and 112 sustained damage to the extent of £1247. The loss of nets and other fishing material amounted to no less a sum than £43,814—making a gross loss in the year of £59,825. This amount is more than double that sustained by like casualties in the preceding year. Detailed particulars of these disasters will be found in Table V. Appendix D, to which reference is made; and it may be mentioned that this is only the second year during which such information has been collected in Scotland.

Boats wrecked and damaged.

Amount of loss in Boats and in Fishing Material.

EAST COAST HERRING FISHERY.

Following the course which has been adopted for the last three years, some details will now be given, taken from the reports of the inspectors and district officers, regarding the herring fishery of 1885, in each of the twenty-six districts into which the coasts of Scotland are divided for fishery purposes, beginning with the seventeen on the East Coast. These are—Eyemouth, Leith, Anstruther, Montrose, Stonehaven, Aberdeen, Peterhead, Fraserburgh, Banff, Buckie, Findhorn, Cromarty, Helmsdale, Lybster, Wick, Orkney Isles, and Shetland Isles.

East Coast Herring Fishery.

Seventeen East Coast Districts.

EYEMOUTH DISTRICT.

From Amble, in the county of Northumberland, to the east side of St Abb's Head, both inclusive, with Coquet Island, Holy Island, and the Farne Islands.
District Fishery Office—Berwick-on-Tweed.

Boundary of District.

The herring fishery of 1885 was less productive in Eyemouth district than it has been for the preceding eight years. The number of barrels cured was 54,964 less than in 1884, and 23,000 less than the average number cured during the last ten years. Herrings were very scarce on that part of the coast, and unusually boisterous weather prevailed in August, the most important fishing month of the year, when the entire fleet of boats was kept on shore no fewer than ten fishing nights, while only a portion of them were at sea on several other nights. During the season the boats numbered 346, being 80 fewer than were employed in 1884. The gross takes of each boat ranged from 30 to 300 crans, and the average was 114 crans. The best week was that ending 12th September, when the average catch reached 30 crans per boat. The fishing began at Eyemouth in the first week of June, but it did not become general in the district until the latter half of July, and it was brought to a close on 19th September. An unusually large quantity of mackerel was taken in the herring nets during the early part of the season, and it was believed that mackerel, being on the fishing grounds, kept the herrings away. The quality of the herrings throughout the season was the worst ever seen in the district—a large proportion of them consisting of small inferior maties. The price varied from 4s. to 48s. per cran—the average being 14s.—and altogether the season was an unprofitable one both to fishcurers and to the majority of the fishermen. This will be all the more regretted when it is stated that, owing to a storm which arose on the night of 12th August, 600 nets, worth £1500, were lost, and that during the second week of September, more nets, of the value of £500, were lost or damaged by fouling, or by the weight of fish which they took. About £3700 was paid during the season for steam tugs towing the boats to and from the fishing grounds, and at one time the number of these vessels employed was no fewer than 33.

Unproductive Fishing.

Boisterous Weather.

Number of Boats.

Best week.

Duration of Fishing.

Large takes of Mackerel in Herring Nets.

Herrings of poor quality.

Prices of fresh Herrings.

Storm and loss of Netting.

33 Steam Tugs employed towing Boats.

LEITH DISTRICT.

From the west side of St Abb's Head, inclusive, westwards, and including all the south side of the Firth of Forth; and its north side to Buckhaven exclusive.
District Fishery Office—Leith.

Boundary of District.

Leith district has both a summer and a winter herring fishery.

Summer Fishing—Particulars thereof.

The summer fishing began last year about the middle of July, and was prosecuted until the 10th of September. About 62 boats were at one time employed, but 40 was the average number. The greater part of the catch was taken at a distance of from 12 to 40 miles off-shore. The largest take was 86 crans, and the best week of the season yielded 1110 crans. The average catch per boat was 128 crans, as against 153 in 1884. The herrings taken were of unusually poor quality, and contained a large proportion of spent fish. The total catch of the fishing was 5120 crans. As in recent years, Dunbar and Newhaven were the only stations in the district where the summer fishing was carried on. The winter herring fishing was prosecuted with good success from October 1884 till March 1885, when it was discontinued. The fish landed were of fairly good quality, and were chiefly caught between Inchkeith and Queensferry. 100 boats were employed. Their total catch was 5505 crans, the greater part of which was consumed fresh.

Winter Fishing—Its prosperity.

Grounds fished.

Anstruther District.

Boundary of District.

From Buckhaven to the south side of Tay, both inclusive.

District Fishery Office—Anstruther.

575 First-class Boats.

Nearly all fished elsewhere.

Summer Fishing moderately successful.

Particulars thereof.

In Anstruther district, 575 first-class decked boats were fitted out last year for the summer herring fishery, but only 14 remained at home; the others prosecuted the industry at different stations on the East Coast, from Shields, in England, to the Shetland Isles. The summer fishing commenced about 13th July, and was moderately successful. The largest takes of herrings, and those of the best quality, were got in the latter end of that month, about 20 miles east of the Island of May. The boats made repeated visits to the distant fishing grounds, 40 to 60 miles at sea; but very few herrings were caught there, nor were many found on the in-shore grounds in the Firth of Forth. The total summer catch landed in the district amounted to 4021 crans, but more than half of it was brought by boats from the Aberdeenshire fishing grounds, from which they had been driven by stress of weather. The winter herring fishing was more successful than in any former season. 220 boats were employed, and no fewer than 40,636 crans were taken. The herrings were of a fair average quality, and, with the exception of a small portion which was bloated or kippered, they were all sent to the home markets in a fresh state. The prices were sometimes so low that the cost of railway carriage to the markets was considerably more than what was paid to the fishermen for the herrings. The industry was prosecuted all over the Firth of Forth, but principally near Fife Ness and the Island of May.

Great success of Winter Fishing.

Disposal of Herrings.

Railway Carriage more than paid for Fish.

Grounds fished.

Montrose District.

Boundary of District.

From the north side of Tay to Bervie, both inclusive.

District Fishery Office—Montrose.

Number of Boats.

During 1885 Montrose district had 113 boats engaged in the

fishing, being 33 less than in 1884. A few boats began to fish early in July, but they met with little success until the 20th of that month, when the regular fishing commenced. The most successful weeks were those ending 15th, 22nd, and 29th August, and 5th September. The fishing was brought to a close by stormy weather on 12th September, and resulted in an average catch of 148½ crans per boat. In the previous year, the average was 184½ crans. The fishing grounds extended from 5 to 70 miles seaward; but the most productive fishing was got from 15 to 30 miles off-shore, where individual takes of 86, 90, and 96 crans were landed. At the various stations, the average catches per boat for the season were—Arbroath, 230 crans; Montrose, 130 crans; Johnshaven, 118 crans; and Gourdon, 171 crans. The quality of the herrings was very poor—the great bulk of them consisting of soft, small, and spent fish. The winter and spring herring fishing of the district was most unsuccessful, and only produced 265 crans, as against 2387 crans in the previous year.

Progress of Fishing.
Best weeks.
Average Catch.
Most productive Grounds.
Averages at the Stations.
Quality very poor.
Winter Fishing unsuccessful.

Stonehaven District.

From Bervie, exclusive, to Skateraw, inclusive.

District Fishery Office—Stonehaven.

Boundary of District.

In the district of Stonehaven, 91 boats were employed in the season of 1885, of which 80 belonged to Scotland and the others to Cornwall, being 10 fewer than in the preceding year. The fishing began on 13th July, and continued till 2nd September, when it was ended by stormy weather. The average catch of the fleet was 181 crans per boat, as against 139 in 1884. The week ending 29th August yielded the best fishing of the season, during which each boat averaged 59½ crans. Exceptionally heavy takes were landed on the 27th, 28th, and 29th August, when the boats averaged 25, 35, and 42 crans respectively. The herrings were generally of a small size and of inferior quality during the greater part of the season, being soft and tender. Some of the takes landed in August—particularly on the 29th of that month—consisted of fish of good quality, and of a large size. The fishing grounds extended from 3 to 70 miles seaward, but the largest takes were got from 20 to 35 miles off-shore. The weather was marked by the prevalence of prolonged calms, occasional fogs, and three violent gales. Five fishermen were unfortunately drowned in this district when prosecuting their calling during 1885. The winter herring fishing was almost a failure—only 200 crans having been caught. The number taken in 1884 was 600 crans.

Number of Boats.
Average Catch of Fleet.
Particulars of Fishing.
Quality of Herrings.
Grounds Fished.
Weather.
Five Fishermen drowned.
Winter Fishing.

Aberdeen District.

From Skateraw, exclusive, to Aberdeen, inclusive.

Disrict Fishery Office—Aberdeen.

Boundary of District.

Aberdeen district had a fishing fleet of 378 sail in 1885, comprising 301 Scottish boats, 74 English, and 3 Irish, as against 341 Scottish and 33 English in 1884, being a gross increase of 4 boats. The industry was begun in July, and closed early in

Scottish, English, and Irish Boats.

September, and the best fishing grounds lay from 30 to 70 miles at sea. The two most productive weeks of the season were those ending 1st and 29th August, during which the boats averaged 24 and 31 crans respectively. The highest individual take was 117 crans, and the most successful boat landed in the year a gross catch of 450 crans; the least successful got 20 crans. The English and Irish boats made a poor fishing, and their gross takes were much under the general average of the season. The fleet included five steam fishing boats. Of these, four were of a superior class and well equipped, and having large meshed nets the herrings they captured were of a large size. The season's catch contained a greater proportion of small herrings than that of any former year. It yielded an average of 158½ crans to each boat. In 1884 the average was 176½ crans. The total number of barrels cured was 81,815, being a decrease of 7898 barrels from the cure of 1884. Calms and fogs occasionally delayed the boats from getting to land until their herrings were spoilt, and 3500 crans of such fish were partly sold for manure and the remainder thrown into the sea. Altogether, unfavourable weather prevailed during the season. Had it been otherwise, there would have been a much better fishing, as herrings were abundant off the coast. On the morning of 13th August a large decked boat, with a great catch of herrings on board, foundered during a violent storm from the north-east, and unfortunately the whole crew perished. On the same morning a man fell overboard from another boat and was also drowned.

Progress of Fishing.

Steam Fishing Boats.

Produce of Season.

Unfavourable weather and its results.

Boat foundered and Crew perished.

Peterhead District.

Boundary of District.

From Aberdeen to Rattray Head, both inclusive.

District Fishery Office—Peterhead.

In Peterhead district 722 boats were employed in 1885—of which 612 fished from Peterhead, 78 from Boddam, and 32 from Port Erroll—being a decrease of 41 boats from the fleet of 1884. The average catch per boat was 186⅓ crans, as against 240 crans in the preceding year. The fishing began early in July, and at that time there was every indication that it would be abundant. The herrings taken at this early period of the season were very small, and owing to the unsatisfactory nature of the preceding year's transactions in such herrings, they were only saleable at very low prices—some of the takes indeed having only realised 1s. per cran. With the view of discouraging a continuance of this early fishing, it was arranged between the curers and the fishermen generally, that the agreed on prices at which herrings were to be bought during the season were not to come into operation till the 20th of July, thus leaving any catches brought on shore before that time to be sold for what they would bring. This arrangement had, to a great extent, the desired effect, as scarcely any encouragement was thereafter given to boats landing herrings on an earlier day. A number of individual takes during the season ranged from 100 to 122 crans. The largest aggregate catch of any one boat was 430 crans, and the lowest 50 crans. The

Number of Boats at the different Stations.

Average catch.

Small Herrings.

Early Fishing discouraged.

Progress of Fishing.

fishing was heaviest in the week ending 15th August, when the fleet averaged $44\frac{3}{4}$ crans per boat. Until 12th August the grounds usually fished lay from 20 to 60 miles seaward; but on that day great shoals of herrings were discovered on the in-shore grounds, 2 to 8 miles off land, when a very abundant fishing was got—the Peterhead boats having averaged 30 crans each, and the Boddam and Port Erroll boats 45 crans. Unfortunately, on the following morning a violent storm from the north-east suddenly broke out, and almost completely stopped the fishing for some days. With the exception of those landed at the commencement of the fishing, the quality of the herrings taken throughout the season was generally much better than in 1884. Of the year's catch about 3000 crans were kippered. There were four vessels employed in the deep-sea fishing, and all the herrings which they took were cured on board. They yielded 2652 barrels, and a considerable portion of them obtained the crown brand. The fishing closed on the 12th September, when it was found that the gross number of barrels cured in the district amounted to 224,087. This was a decrease of 73,889 barrels from the number cured in 1884, but the catch of that year was the largest ever recorded.

Great shoals on in-shore Grounds.

High average Takes.

Storm on 13th August.

Quality of Herrings better than in 1884.

Deep-sea Fishing.

Barrels cured in 1884 and 1885.

Fraserburgh District.

From Rattray Head, inclusive, to Troup Head, exclusive.

Boundary of District.

District Fishery Office—Fraserburgh.

Fraserburgh district had a fleet of 888 boats engaged in the herring fishing of 1885, being an increase of 148 boats on the number in 1884, of which 742 fished from Fraserburgh, 107 from Pittulie, and 39 from Rosehearty. The fishing was successful, although it produced much less than the unprecedentedly great catch of 1884. The aggregate takes yielded an average of 176 crans to each boat, as against $278\frac{3}{4}$ crans in the preceding year. The highest gross catch of any boat was 514 crans, and the lowest about 40 crans. The fishing began at a later date than in the previous year. Notwithstanding this, however, the takes landed at its commencement contained an unusually large quantity of very small herrings, and as these were comparatively unsaleable, very few boats went to sea until about 20th July, when the fishing became general. As the season advanced the herrings improved in size, and upon the whole they were of superior quality to the catch of the preceding year. The most successful fishings were made on the weeks ending 1st, 8th, 22nd, and 29th August, and 5th September, when a number of boats landed catches of about 100 crans each. The best fishing grounds extended from 10 to 65 miles from land. The weather throughout the season was generally unfavourable. Fogs and calms prevailed to some extent during the early part of the fishing; and on the evening of 12th August, after half the fleet had gone to sea, a strong gale blew from the north-east, and, unfortunately, two large decked boats, with their entire crews, consisting of twelve men and one boy, were lost. This gale also caused great loss in nets, many of which were sunk or torn. The total

Fleet of Boats.

Number at each Station.

Average catch.

Particulars of Fishing.

Quality of Herrings superior to Takes of 1884.

Grounds fished.

Weather unfavourable.

Storm of 12th August.
2 Boats lost and 13 Persons drowned.

Barrels cured in 1885 & 1884. Herrings Kippered and Tinned.

number of barrels cured in the district was 276,319, as against 348,368 in 1884, being a decrease of 72,049 barrels. Upwards of 12,000 crans of herrings were kippered during the season for the home trade, and 3570 crans were preserved in tins, chiefly for exportation.

BANFF DISTRICT.

Boundary of District.

From Troup Head, inclusive, to Cullen, exclusive.
District Fishery Office—Macduff.

Number of Boats. Average Catch. Progress of Fishing.

In Banff district 107 boats were engaged in the fishing of 1885, being 43 less than in 1884. Although the fishing was not so successful as that of the previous year, it yielded a full average catch. It began on 20th July—a week later than usual—and ended on 12th September. The average fishing of each boat was 177½ crans; that of 1884 was 210½ crans. The highest aggregate catch of any one boat for the season was 405 crans, and the lowest 40 crans. The most successful weeks were those ending 25th July and 29th August. The grounds chiefly fished lay from 20 to 30 miles at sea, but the heaviest takes were got in-shore, from 2 to 6 miles from land. At 2 miles from land individual takes of 60, 80, and up to 135 crans were landed, and altogether the in-shore grounds were more productive than they had been for a number of years. Further out than 40 miles at sea, scarcely any fish could be found. The quality of the herrings was much better than those got in 1884, and the takes contained a greater proportion of full fish. The gross quantity cured in the season was 26,230 barrels, while that in 1884 was 40,787 barrels, showing a decrease of 14,557 barrels in 1885. The winter herring fishing proved a complete failure in 1885, and was only prosecuted for a short time.

Grounds Fished. Large Takes got In-shore. Barrels cured in 1885 and 1884. Winter Fishing.

MORAY FIRTH DISTRICTS, embracing—

BUCKIE DISTRICT.

Boundary of District.

From Cullen to east side of Spey, both inclusive.
District Fishery Office—Buckie.

FINDHORN DISTRICT.

Boundary of District.

From west side of Spey to south side of Kessock Ferry, both inclusive.
District Fishery Office—Burghead.

CROMARTY DISTRICT.

Boundary of District.

From north side of Kessock Ferry to south side of Mickle Ferry, both inclusive.
District Fishery Office—Cromarty.

HELMSDALE DISTRICT.

Boundary of District.

From north side of Mickle Ferry to Dunbeath, both inclusive.
District Fishery Office—Helmsdale.

Aggregate Fleet.

The four districts in the Moray Firth, extending from Cullen to Dunbeath, possessed an aggregate fleet last year of 1286 first class

boats, but the most of them went to fish at other stations. The number which remained at home was 262, being a decrease of 38, as compared with 1884, but nearly all these were old and inferior craft, and poorly equipped with netting. The gross quantity of herrings, however, which was taken and cured in the four Moray Firth districts, amounted to 53,577 barrels, being 18,857 more than in the preceding year. The average catches per boat in these districts were—Buckie 152 crans, Findhorn 125 crans, Cromarty 149¼ crans, and Helmsdale 121 crans. This success is greater than had been achieved for many years, and was entirely owing to large shoals of fish having returned to the in-shore grounds, 1 to 4 miles from land, which latterly they had almost deserted. But the herrings taken were generally of rather a small size—a considerable number of them indeed being maties, while only about one-third of the gross catch consisted of large full fish. The fine first-class boats of the district, which went to fish in other waters, were fully equipped with gear of the best description, and generally had a successful season's fishing. The winter herring fishing in the Moray Firth districts yielded 12,629 crans, which is considerably above the average of former seasons.

Boats employed in Moray Firth.

Increase in Barrels cured.

Successful Fishing on In-shore Grounds.

Other Boats also successful.

Winter Fishing.

Lybster District.

From Dunbeath, exclusive, to East Clyth, inclusive.

Boundary of District.

District Fishery Office—Lybster.

Lybster district had a fleet of 112 boats engaged in the summer fishing of 1885, being 7 less than in the previous year. The average catch was 138 crans per boat, being the highest average ever recorded in the district. In 1884 the average was only 37½ crans. Owing to the succession of unproductive fishings in this district for more than twenty years, little money had been expended in providing new boats, and a large proportion of those in use had become old and unfit for going far out to sea, and they were only equipped with inferior netting. Fortunately, last season, the herring shoals came close in-shore, and nearly the whole catch was got within 3 miles from land. The fishing began on the 18th of July, and was continued till the 22nd of August. Individual takes of from 50 to 90 crans were sometimes landed. The largest aggregate catch which any boat made during the season was 280 crans, and the smallest 30 crans. The quality of the season's catch was about equal to that of recent years, one-third of it consisting of full herrings, and the other two-thirds maties and spent fish. The gross quantity cured was 19,099 barrels as against 5347 in 1884, being an increase of 13,752 barrels. During the winter herring fishing the weather was very unpropitious, and the gross catch only amounted to 814 crans, as against 1189 crans in 1884.

Boats employed.

Average Catch, highest ever recorded in District.

Shoals came close In-shore.

Progress of Fishing.

Large increase in Barrels cured.

Winter Fishing.

Wick District.

Boundary of District.

From East Clyth, exclusive, to Cape Wrath, inclusive, including the Island of Stroma in the Pentland Firth.

District Fishery Office—Wick.

Fleet of Boats. Average Catch in 1885 and 1884. Progress of Fishing, and Quality of Herrings. Grounds Fished. In-shore Grounds most Productive. Boats fished 48 Nights during Season. Severe Gale and its consequences. Barrels cured. Winter Fishing fairly successful. Manure made from Fish Offal and inferior Herrings.

In Wick district a fleet of 483 boats was employed in the herring fishing of 1885, being a decrease of 60 boats from the number in the previous year. The average catch per boat was 173½ crans, as against 190 crans in 1884. The fishing began on 1st July, but was only prosecuted to a limited extent until the 20th of that month, as any fish which were landed up to that time consisted of small herrings, for which there was very little demand. Thereafter, till 5th August, the takes were of good quality, more than one half of them being large, full fish; but during the remainder of the season, which lasted till the end of August, they were largely mixed with small herrings. The finest herrings were captured at from 30 to 50 miles seaward; but the bulk of the season's catch was got on the in-shore grounds, 3 to 10 miles from land. The highest individual take was 127½ crans, and takes varying from 80 to 112 crans were frequently landed. Five nights were lost owing to stormy weather, and, in addition, fogs and calms caused occasional interruptions to the fishing. Altogether, however, the boats got to sea 48 nights of the regular season. There was a severe gale on the night of the 12th August, by which so great a loss in netting was sustained that many of the boats were disabled for the rest of the season. Had it not been for this casualty, it is believed that the catch would have been greater than in 1884. As it was, the total number of barrels cured was 117,754, being only 9386 fewer than were cured in that very abundant season. The winter herring fishing, which was prosecuted from 6th January till 14th March was fairly successful. 85 boats were engaged in it, and the gross catch amounted to 4379 crans, as against 2693 crans in 1884. These winter herrings, which were valued at about £5000, were either sold in a fresh state or made into bloaters. There are two establishments at Wick for the manufacture of manure from fish offal and inferior herrings, and they carried on a large business last season.

Orkney District.

Boundary of District.

The Orkney Islands; and Swona in the Pentland Firth.

District Fishery Office—St Margaret's Hope.

Fleet of 260 Boats. Average Catch. Fishing poor at opening, but abundant afterwards.

Orkney district employed 260 boats in 1885, being 30 fewer than in the preceding year. Of these, 102 fished at St Margaret's Hope section, and 158 at Stronsay section. The average catch for the district was 154 crans per boat, as against 126 crans in 1884. The fishing began with a few boats on the second week of July, but it was not prosecuted with much vigour until the 20th of that month, as the quality of the herrings landed before that date was inferior, and there was little demand for them even at exceedingly low prices. This early fishing closed with a catch of only 742 crans, as against 12,028 crans landed up to the same

day of the previous year. After the 20th of July, a large regular fishing, which continued for about three weeks, was made on the in-shore grounds, from 1 to 6 miles off the Island of Copinshay. These grounds contained large shoals of excellent herrings, two-thirds of which were full fish, and they yielded the best fishing during the season. In the Stronsay section the boats generally went to the off-shore grounds, at a distance of from 10 to 40 miles seaward. They had fairly good success, but the takes landed were frequently of inferior quality, containing a large proportion of maties and spent fish. On 15th August the boats at St Margaret's Hope section got the high average of 51 crans each. After the middle of that month the fishing became light, and it finally closed on 2nd September. The gross catch was the highest ever reached in the district, and the quantity of barrels cured was 53,300, as against 48,824 barrels in 1884.

Richest Grounds In-shore.

Boats averaged 51 Crans on 15th August.

Gross Catch highest ever reached in District.

Shetland District.

Comprising the Shetland Isles, and Fair Isle and Foula Island.
District Fishery Office—Lerwick.

Boundary of District.

Shetland district in 1885 yielded a much larger herring fishing than it did even in the unprecedentedly abundant year of 1884, although the fleet of boats engaged was 107 fewer than in that season. The number of boats in 1885 was 825, as against 932 in 1884. Of this fleet, 394 boats, including 45 small six-oared boats, belonged to the district, and the remainder came from other districts on the East Coast, from the Isle of Man, and from Ireland. The average catch of the whole fleet was 280 crans per boat, making an aggregate catch of 231,000 crans, thus exceeding the great fishing of the preceding year by 57 crans in the average per boat, and 23,000 crans in the gross total. There are 114 curing establishments in the district, which were occupied during the season by 74 curers, and no less than 12,000 persons were employed in connection with the industry. The early fishing opened on the 20th of June on the west, or Atlantic side of the Islands, which was three weeks later than in the preceding year, and it closed about the middle of July. The estimated catch was 110,000 crans, being 21,000 crans more than the produce of the early fishing of 1884. About the end of July, all the boats went round to the East Coast or North Sea side of Shetland, when the late fishing commenced, and was carried on with great energy till 12th September. At Balta Sound daily average takes, ranging from 20 to 35 crans a boat, were landed; and at Cullivoe from 30 to 40 crans. Individual boats frequently got takes of from 80 to 100 crans; and a boat at Balta Sound landed the unprecedentedly large take of 160 crans. The curers were unable satisfactorily to deal with such great fishings; and they requested the fishermen to remain on shore for a few days, which they unwillingly agreed to do. But notwithstanding this, more herrings were landed at Balta Sound than could possibly be cured, and large quantities had to be sold for manure or thrown into the sea. Many of the boats got each an aggregate catch in the season of from 400 to 500 crans, and a few of them as many as 600 crans.

Fishing larger than in previous year, although fewer Boats engaged.

Number of Boats and places to which they belonged.

Average and aggregate Catches of whole Fleet.

Curing Premises.

12,000 Persons employed.

Particulars of the early Fishing.

Late Fishing.

Great Takes at Balta Sound and Cullivoe.

More Herrings landed than could be Cured.

Aggregate Catches.

Boats in each Section. Grounds Fished. Quality of Herrings. Weather. Disasters at Sea. Barrels cured.

During the early fishing 500 boats fished at Unst section, and 280 at Lerwick section; but at the late fishing the latter had a fleet of 545 boats, while the former had only 280. The grounds fished lay from 6 to 40 miles from land. The quality of the herrings was fairly good all the season. With the exception of the week ending 15th August, the weather was generally suitable for prosecuting the industry. A severe storm broke out on the morning of the 13th of that month, when a large quantity of nets were lost or torn. During the year three boats were wrecked, and five fishermen drowned. The total number of barrels cured in the district during the season was 370,238, of which 195,235 were cured in the Unst section, and 175,003 in the Lerwick Section; being an increase in the district of 70,121 barrels over the number cured in 1884.

SUMMARY OF EAST COAST HERRING FISHING.

Eight Districts show an increase and nine a decrease. Net decrease of 137,068¼ Barrels cured in 1885, as against 1884. Greatest increase in Shetland. Continued prosperity of the Fishery there. Improvement in Moray Firth Districts.

The returns of the Herring Fishing on the East Coast of Scotland for 1885 show an increase, in eight districts, on the gross quantity of herrings cured in 1884, of 112,335¾ barrels, and a decrease in nine districts of 249,404 barrels, resulting in a net decrease of 137,068¼ barrels in 1885, as against 1884. The districts which exhibit the largest decrease are Eyemouth, Montrose, Peterhead, Fraserburgh, and Banff. Those which mainly contributed to the increase are Stonehaven, Findhorn, Helmsdale, Lybster, Orkney, and Shetland. The greatest increase, however, is due to Shetland, in which were cured 70,121 barrels more than in the preceding year, notwithstanding that the fishing of that year was the greatest ever recorded there. Attention has been called, in previous Reports, to the rapid and extraordinary development of the herring fishery in Shetland since 1874. In that year the total quantity of herrings cured at all the stations in Shetland amounted to only 1100 barrels, while in the year now reported on 370,238 barrels were cured. The improvement in the yield of the Moray Firth districts was owing to shoals of herrings having come to the in-shore grounds.

East Coast Fishing of last Fifty years.

The official returns of herrings cured on the whole of the East Coast of Scotland for the fifty years preceding last year, on the average of each period of ten years, show a large and continuous increase. They are as follow:—

Yearly average of Barrels cured in periods of ten years.

Periods of Ten Years.	Yearly average of Barrels cured.
1835 to 1844 inclusive,	428,343
1845 „ 1854 „	495,879
1855 „ 1864 „	515,368
1865 „ 1874 „	602,375
1875 „ 1884 „	902,665

Barrels cured in 1885, 1,318,982½.

Decrease per cent. in 1885 from 1884.

The number of barrels cured in 1885, when compared with that of 1884, shows a decrease of 10·39 per cent.; when compared with

the average of the preceding 10 years, it shows an increase of 46·12 per cent.; of 25 years, 87·06 per cent.; and of 50 years, 123·96 per cent.

Increase in 1885 on preceding 10, 25, and 50 years.

WEST COAST HERRING FISHERY.

The nine fishery districts on the West Coast of Scotland are:— Stornoway, Loch Broom, Loch Carron and Skye, Fort-William, Campbeltown, Inveraray, Rothesay, Greenock, and Ballantrae.

Nine West Coast Districts.

Stornoway District.

The Islands of Lewis, Harris, North Uist, Benbecula, South Uist, Barra, and the smaller Islands within this range; also St Kilda.

Boundary of District.

District Fishery Office—Stornoway.

Stornoway district had a successful herring fishing in 1885, the gross catch having been among the highest it had ever reached. A fleet of 1081 boats was employed in the industry, being 86 fewer than in the preceding year. About 200 of these were native boats. The remainder came from numerous other places. The average fishing of the whole district, was 87 crans for each boat. Of the two sections into which the district is divided, Stornoway section had 591 boats, and Barra 490, and their estimated average catches were 64 and 100 crans per boat respectively. The fishing was begun by a few boats early in May, and became general about the 20th of that month. It was closed at the end of June, with the exception that a few native boats continued fishing, and with good success, until the middle of September. The total quantity of herrings cured at the twelve stations in the district was 114,781¾ barrels, as against 116,010½ in 1884. In Stornoway section, as is usually the case, the best fishing grounds at the commencement of the season lay from 10 to 40 miles north-east of the Butt of Lewis, and midway between the Butt and Cape Wrath. By far the heaviest takes, and the largest portion of the season's catch, were brought from the vicinity of the small Island of North Rona, lying about 40 miles north-east of the Butt; but the herrings caught on this distant fishing ground were generally of inferior quality, as compared with those got nearer land or in the Minch. From the end of June to the middle of September, herrings appeared in large quantities, and of good quality, from 4 to 10 miles off Stornoway. In Barra section, the principal fishing grounds lay on the west, or Atlantic side of the Island, 20 to 30 miles at sea. The best day's fishing was got on the 20th June, when 390 boats averaged 18 crans each. Towards the end of the season, good fishing was obtained in the Little Minch, 4 to 5 miles off-shore. The curers asked that the fishing should not begin before 20th May, and this having been generally agreed to by the fishermen, the quality of the herrings taken was better in 1885 than in the preceding season. 58,513¾ barrels were exported direct to the Continent, of which 43,899 went to St Petersburg. Cured early herrings from the district of Stornoway sometimes bring large prices on the Continent, where they are greatly prized.

Fishing successful. Boats employed. Average Catches in the two Sections. Duration of Fishing. Barrels cured. Grounds fished in Stornoway Section. Grounds fished in Barra Section. Barrels exported direct to Continent.

The first shipment sent there last year was from Barra. It consisted of 2000 barrels, which realised from £5 to £7 a barrel. A large and increasing trade is carried on in this district in kippering herrings. Last season nearly one fourth of the entire catch, or 18,080 crans, was kippered. 5792 crans were sent fresh or lightly salted to the home markets. The weather in 1885 was fully more favourable in the district for fishing than in the average of recent years. Unfortunately no fewer than 18 fishermen were drowned near the Butt of Lewis on the 4th of March, while engaged in the cod and ling fishing.

High prices realised there.

Herrings kippered and sold fresh.

Weather and Loss of Life at Sea.

Loch Broom District.

Boundary of District.

From Cape Wrath to Diobaig, both exclusive ; including the lochs and islands within this range of coast.

District Fishery Office—Ullapool.

Decrease in Fishing.

The herring fishery in Loch Broom district is entirely prosecuted in the lochs and inland waters by native boats. Its produce, year by year, is extremely fluctuating. For some years previous to 1884 the fishing was very poor. In that year it greatly improved; but last year it again fell off, and only produced about one-half of what it did in 1884. The fishing last season was begun in August, and prosecuted with more or less energy till December. At first only a few boats took part in it; but as other native boats returned from the East Coast, where they had gone to fish, the number gradually increased until it reached 230. The number of barrels cured in the year amounted to 8948, as against 16,700 in 1884. The quality of the herrings was poor, and the prices for which they sold ranged from 15s. to 21s. per cran. Eight steamers were in the district, and these purchased a large portion of the catch in a fresh state for the home markets. Ten curing vessels were fitted out during the year, for the deep-sea fishing, and they cured on board 5123 barrels, or nearly two-thirds of the total quantity cured in the district.

When prosecuted.

Boats employed.

Barrels cured.

Quality and Prices of Herrings.

Steamers.

Curing Vessels.

Loch Carron and Skye District.

Boundary of District.

From Diobaig, inclusive, to Loch Nevis, exclusive ; including the lochs and smaller islands within this range of coast ; also the islands of Skye, Scalpa, Raasay, Rona, and Croulin.

District Fishery Office—Broadford.

Winter and Summer Fishing.

When carried on.

Loch Carron and Skye district had a winter and a summer herring fishing in 1885, both of which were fairly successful. The former was carried on in the months of January and February, and also in November and December. Its gross catch amounted to 4140 crans, as against only 420 crans in 1884. The summer fishing was prosecuted in July, August, and September. At one time 264 boats were employed in the district, but 136 was the average number. The herrings were principally caught in the sounds of Scalpa and Raasay; but very good fishing was got in Loch Snizort and Loch Dunvegan, and takes were also landed in Loch Ainort and Loch Carron. The fishing in Loch Hourn, which was so abundant three or four years ago, was almost a failure last season.

Number of Boats.

Grounds Fished.

Barrels cured.

The total number of barrels cured was 15,950, or 1588 barrels less than in 1884. The herrings were generally of excellent quality, and the prices they brought ranged from 6s. to 37s. per cran. There were 32 curing vessels fitted out in the district for the herring fishery, and their gross catch yielded 8204 barrels, all of which were cured on board. Four steamers were engaged in buying fresh herrings in the district and conveying them to Strome Ferry, Oban, and Glasgow, and their purchases during the season amounted to 5280 crans.

Prices per Cran.

Curing Vessels.

Steamers employed.

FORT-WILLIAM DISTRICT.

From Loch Nevis to Oban, both inclusive; including the lochs within this range of coast; also the islands of Canna, Rum, Eig, Muck, Coll, Tyree, Iona, Mull, Lismore, Kerrera, and the smaller islands.

Boundary of District.

District Fishery Office—Oban.

In Fort-William district the herring fishing of 1885 was carried on in the sea-lochs, sounds, and bays. About 197 boats were at one time employed. The usual number, however, did not exceed 70. The fishing began in July, but it was very light till the middle of October. Of all the lochs, Loch Linnhe and Loch Eil were the most productive, and the boats which used seine or circle-nets got the best fishing. The total number of barrels cured was 2412, as against $7906\frac{1}{2}$ in 1884; but the great bulk of the catch was sent away by steamers to be consumed fresh. Prices of fresh herrings ranged during the season from 4s. to 20s. per cran. Seventeen curing vessels were fitted out in the district for the herring fishery. During the month of October a disturbance arose in Loch Eil, which threatened to become serious, between the native fishermen and some Loch Fyne fishermen who were using seine-nets. The seine-net fishermen were landing heavy takes of herrings, one of which yielded 199 crans, while the native fishermen were getting scarcely any with their drift-nets; and the latter compelled the former to stop fishing. The Board deemed it desirable in the circumstances to send H.M. cutter 'Daisy' to the loch to restore order. In this she was quite successful. The seine-net fishermen resumed their work and they were not again molested.

Grounds Fished.

Boats employed.

Seine-net Fishermen most successful.

Barrels cured.

Herrings sold Fresh.

Disturbance between Drift-net and Seine-net Fishermen

H.M. Cutter 'Daisy,' sent to restore order.

CAMPBELTOWN DISTRICT.

From Tayinloan, inclusive, round the Mull of Cantyre to Skipness Point, inclusive; including the islands of Colonsay, Jura, Islay, Gigha, and Sanda.

Boundary of District.

District Fishery Office—Campbeltown.

In the district of Campbeltown the herring fishing last year was prosecuted by a fleet of 402 boats, of which 180 used drift-nets, and 222 circle or seine-nets. A few boats occasionally fished in April and May, but the fleet generally did not begin work till June. The industry was continued till October, when the herrings seemed to have left the grounds. The season was one of the most successful which the district ever had. The gross quantity of herrings cured was 45,342 barrels, being an increase of 4421 barrels on the number cured in the abundant season of 1884. The grounds principally fished lay in the vicinity of Carradale and

Drift-net and Seine-net Fishermen employed.

Season most successful.

Barrels cured.

Fishing Grounds.

along Kilbrannan Sound; and the best takes were got in the weeks ending 19th September and 10th October, which yielded 4790 and 4764 crans respectively. Upon the 12th September a crew of eight men with two boats, using circle or seine-nets, landed 240 crans, which realised £480. During the season, several other crews of eight men, also with two boats and seine-nets, realised from £1000 to £2000 for the herrings which they captured. Although prices were much lower than in former years, the total value of the season's catch was estimated to be worth £67,000. As many as 21 buying steamers were employed in conveying the herrings from the boats at the fishing grounds to Glasgow, for distribution over the country. The quality of the fish taken during the year was superior.

Large earnings of Seine-net Boats.

Value of Season's Fishing.

Herrings taken to Glasgow by Steamers.

Inveraray District.

Boundary of District.

From Oban to Tayinloan, both exclusive; including the lochs and islands within this range of coast, and from Skipness Point and Ardlamont Point, both exclusive, for both sides of Loch Fyne, to the head of the Loch.

District Fishery Office—Ardrishaig.

Fishing Fleet.

In Inveraray district a fleet of 264 boats was employed in the herring fishing of 1885. About two-thirds of these boats used seine or circle-nets, and the remainder drift-nets. The industry yielded 26,379 barrels of cured herrings, or 6731 more than in 1884, but last year's produce was under the average of the preceding twenty years. A few boats began fishing in May, and about 2050 crans were landed by 1st June, at which time the regular season commenced. A number of very heavy takes was got by the seine-nets. During the week ending 27th June, two boats using these nets and fishing together, landed a take of no fewer than 338 crans, for which they received £413; and on 10th October other two boats got 315 crans, which were sold for £332. Most of the seine-net boats were successful, but some of them caught very few fish. The drift-net fishing, on the other hand, was a complete failure. The grounds fished extended from Minard in Upper Loch Fyne to Kilbrannan Sound. Large shoals of herrings were found in Loch Fyne, but they left the loch much sooner than usual. The quality of the takes landed was very superior, and fully maintained the high character of that loch for the excellence of its herrings. Prices were much lower than in previous years, the average being about 25s. per cran. In 1884 the average was 38s. per cran and in 1883, 45s. From 10 to 16 swift steamers were engaged in purchasing the herrings on the fishing grounds as soon as they were caught, which they carried to Glasgow, from whence a large proportion was sent by rail to the English markets.

Barrels cured.

Success of Seine-net Boats.

Failure of Drift-net Boats.

Grounds Fished.

Quality of Loch Fyne Herrings.

Prices.

Herrings sent to Glasgow and England.

Rothesay District.

Boundary of District.

From Ardlamont Point, inclusive, to Roseneath Point, exclusive; including the lochs within this range of coast; also Bute and Arran.

District Fishery Office—Rothesay.

Fishing Light.

The herring fishing still continues light in Rothesay district,

although the gross catch last year was about 3000 crans more than in 1884. From 20 to 185 boats were employed during 1885, and the quantity of herrings cured was 3673 barrels. The rest of the catch was disposed of fresh. Prices ranged from 8s. to 45s. per cran. The fishing commenced in June—a fortnight earlier than usual—and continued till December. At first, shoals of small herrings were found upon the Bute Coast, but during the rest of the season the fish landed were of a larger size. Heavy takes were occasionally got with seine-nets. The two most successful seine-net boats, having together crews of eight men, sold their season's catch for £520, and the most successful drift-net boat, having four men, got £165 for its fishing. Herrings were captured during the season in Loch Long, Loch Striven, The Kyles of Bute, the Arran Coast, between Bute and the Cumbraes, and on the Ayrshire coast. Fourteen steamers were occasionally employed among the fleet, buying the herrings for the home markets. Six curing vessels were fitted out in the district for the herring fishery.

Boats engaged. Barrels cured. Account of Season's Fishing. Fishing Grounds. Curing Vessels.

Greenock District.

From Glasgow, westwards, on the north side of the River Clyde, to Roseneath Point, both inclusive, including Gareloch ; on the south and east side of the River and Firth of Clyde to Ayr, exclusive, including the Cumbraes. Boundary of District.

District Fishery Office—Greenock.

In the Greenock district the herring fishing of 1885 was more successful than it had been for some years. The number of barrels cured was 8813, as against 4129½ in 1884. The fishing began in May, and was continued till the close of the year, but comparatively few herrings appeared in the district till November, and only a limited number of boats was engaged before that time. In November large shoals of excellent herrings came to the Ayrshire coast, quite close to the shore. The number of boats then employed was 230, some of which used seine or circle-nets, and fishing operations were carried on with much energy for several weeks. The herrings generally were of good quality, and they always commanded high prices for consumption in a fresh state, averaging about 30s. per cran. The principal fishing stations were Largs, Millport, Irvine, Saltcoats, and Ardrossan. Four curing vessels were fitted out for the herring fishery during the year.

Successful Fishing. Barrels cured. Number of Boats and particulars of Fishing. Quality and prices of Herring. Fishing Stations.

Ballantrae District.

From Ayr to Sark River, Solway Firth, both inclusive. Boundary of District.

District Fishery Office—Girvan.

Ballantrae district is particularly distinguished for its winter herring fishery. It has also a summer herring fishery, but the former is by far the more valuable of the two. During last winter 411 boats were employed in fishing; while in summer there were only 70. The winter fishing began on 1st January, and continued till the end of March. Three modes of capturing herrings are practised in this district, namely :—by drift-nets; by seine or circle-

Winter and Summer Fishing. Boats engaged. Three modes of capturing Herrings.

Produce of Winter Fishing. Its estimated value. Best week. Great quantities of Herrings sent by special trains. Summer Fishing and its value. Low prices of Herrings.

nets; and by trammel-nets. Last winter's catch amounted to 27,671 crans, of which 4306 crans were kippered, and 23,365 were sent fresh, or lightly salted, to the home markets. The estimated value of this fishing was £46,673. The industry was prosecuted on the exposed bank of Ballantrae, and it was often interrupted by stormy weather. The most successful fishing was made in the week ending 14th March, when the fleet got regularly to sea. 12,033 crans were then landed, which formed nearly one half of the season's catch. On each day of that week, upwards of 100 waggon loads of herrings were sent away from Girvan by special trains; and 3000 telegrams, in connection with the fishing, passed through the Girvan post office during the week In the summer fishing the 70 boats engaged used drift-nets, and their total catch amounted to 3311 crans. This catch was worth £4755, making the value of the whole year's fishing to be £51,428. The fish taken throughout the season were of fairly good quality, but the prices were very low as compared with those of recent years. In some previous seasons, the same quantity of herrings as were caught last year would have realised £82,000.

SUMMARY OF WEST COAST HERRING FISHING.

Gross increase in Barrels cured. Increase in four Districts and decrease in five. Herrings found at every Station.

The returns of the herring fishing on the West Coast of Scotland show a gross increase in the quantity of barrels cured in 1885 of 12,943¼ on the gross number in the preceding year, 253,969¾ barrels having been cured in 1885, as against 241,026½ in 1884. Of the nine districts, four show a collective increase of 29,487½ barrels, and five a collective decrease of 16,544¼ barrels. The principal increase was in the districts of Ballantrae and Inveraray, and the principal decrease in Loch Broom and Fort-William. During the year herrings were found in greater or less abundance at every station on the West Coast, but with few exceptions the shoals were not large.

The official returns of all the herrings cured on the West Coast of Scotland for the fifty years preceding last year, on the average of each period of ten years, exhibit a continuous large increase. The following table shows the particulars:—

Yearly average of Barrels cured in periods of ten years.

Periods of Ten Years.	Yearly average of Barrels cured.
1835 to 1844 inclusive,	70,067
1845 „ 1854 „	79,300
1855 „ 1864 „	110,665
1865 „ 1874 „	171,196
1875 „ 1884 „	194,135
Barrels cured in 1885, .	253,969¾

Increase per cent. of year 1885 on 1884, and on preceding ten, twenty-five, and fifty years.

The number of barrels cured in the year 1885, when compared with that of 1884, shows an increase of 5·36 per cent.; when compared with the average of the preceding ten years, it shows an increase of 30·64 per cent.; of 25 years, 48·54 per cent.; and of 50 years, 102·16 per cent.

SUMMARY OF HERRING FISHING ON BOTH COASTS.

The following tabular statement gives the particulars of the increase or decrease in the herring fishing of 1885 in each of the twenty-six districts, as compared with that of 1884:— Summary of Fishing on both coasts.

The Twenty-Six Fishery Districts.	Year 1884, Barrels cured.	Year 1885, Barrels cured.	Increase in 1885.	Decrease in 1885.
Eyemouth,	88,351	33,387	...	54,964
Leith,	5,487½	5,253½	...	234
Anstruther,	11,050	9,022	...	2,028
Montrose,	39,175	24,776	...	14,399
Stonehaven,	18,995¼	24,125	5,129¾	...
Aberdeen,	89,713	81,815	...	7,898
Peterhead,	297,976	224,087	...	73,889
Fraserburgh,	348,368	276,319	...	72,049
Banff,	40,787	26,230	...	14,557
Buckie,	21,419	25,175	3,756	...
Findhorn,	3,096	7,687	4,591	...
Cromarty,	1,039	4,676	3,637	...
Helmsdale,	9,166	16,039	6,873	...
Lybster,	5,347	19,099	13,752	...
Wick,	127,140	117,754	...	9,386
Orkney Isles,	48,824	53,300	4,476	...
Shetland Isles,	300,117	370,238	70,121	...
Stornoway,	116,010½	114,781¾	...	1,228¾
Loch Broom,	16,700	8,948	...	7,752
Loch Carron and Skye,	17,538	15,950	...	1,588
Fort-William,	7,906½	2,412	...	5,494½
Campbeltown,	40,921	45,342	4,421	...
Inveraray,	19,648	26,379	6,731	...
Rothesay,	4,154	3,673	...	481
Greenock,	4,129½	8,813	4,683½	...
Ballantrae,	14,019	27,671	13,652	...
Totals,	1,697,077¼	1,572,952¼	141,823¼	265,948¼

The Twenty-six Fishery Districts.

Increase and Decrease of Barrels cured in 1885, as compared with 1884, in each District.

Totals of Increase and Decrease.

These statistics show that the gross quantity of herrings cured in 1885, on both the East and West Coasts, was less than in 1884, by 124,125 barrels, but the official returns for the 50 years preceding last year, on the average of each period of ten years, show a continuous large increase. The following statement gives the particulars of this increase:— Net decrease in 1885 from 1884 on both coasts, and increase during preceding fifty years.

Periods of Ten Years.	Average Number of Barrels Cured Yearly in each Period.	Increase in Average Number of Barrels Cured Yearly in each Period.	Increase per cent. in Average Number of Barrels Cured Yearly in each Period.
1835 to 1844 inclusive,	497,848	...	...
1845 ,, 1854 ,,	575,131	77,283	15·52
1855 ,, 1864 ,,	626,033	50,902	8·85
1865 ,, 1874 ,,	773,575	147,542	23·56
1875 ,, 1884 ,,	1,097,067	323,492	41·81
Barrels cured in 1885,	1,572,952¼		

Yearly Average increase in periods of ten years.

Increase per cent. of year 1885, on average of preceding ten, twenty-five, and fifty years.

The increasing productiveness of the herring fishery of Scotland is shown by these returns to be of a very remarkable character. The gross number of barrels cured in 1885, when compared with the average of the preceding ten years, shows an increase of 43·37 per cent; when compared with the average of the preceding 25 years, it shows an increase of 78·65 per cent; and of the preceding 50 years, 120·32 per cent. The extraordinary development of the fishery becomes even more striking on the fact being borne in mind, which has been stated in previous Reports, that in the year 1809, when the first returns were compiled by the former Fishery Board, the whole number of barrels cured was only 90,185½; while the number cured last year, as shown above, was 1,572,952¼.

Great Development of Fishery since 1809.

HERRINGS CURED ON BOARD OF VESSELS AND ON SHORE.

Vessels; and Herrings cured on Board.

Table I. Appendix A, shows the number of vessels fitted out in Scotland last year for the herring fishery; the districts from which they were fitted out; their tonnage and the number of men; the quantity of netting, salt and empty barrels shipped; and the total number of barrels of white herrings cured on board; distinguishing those cured gutted from those cured ungutted.

Herrings cured on Shore.

Table II. Appendix A, shows the number of barrels of white herrings cured or salted in Scotland last year by fish-curers on shore, and the districts in which they were cured; distinguishing the herrings cured gutted from those cured ungutted.

Total of Herrings cured in Vessels and on Shore.

Table III. Appendix A, shows the total number of barrels of white herrings cured or salted in Scotland last year, both on board of vessels and on shore, distinguishing the herrings cured gutted from those cured ungutted. To this table is added a supplementary note, showing the number of barrels cured or salted last year on the West Coast of Scotland, as stated according to the districts where the herrings were caught.

Herrings cured on West Coast

BRANDING OF HERRINGS.

Number of Barrels Branded larger than in any previous year.

After examination by the Board's officers, 689,325 barrels of the herrings cured during 1885 were found entitled to the brand, being 35,900 more than the number branded in 1884. This is the largest number of barrels ever branded in any one year—a fact which affords most pleasing proof of the growing estimation in which the standard of cure required by the Board is held. Such increased demand for branded herrings is all the more gratifying, seeing that the gross number of barrels cured during 1885 was 124,125 less than in 1884. Had it not been that during last season the fishing boats, owing to their being frequently detained at sea by calms and fogs, were often prevented from landing their herrings in a sufficiently fresh state to be properly cured, the number of barrels branded would undoubtedly have been even greater than

Herrings often not in good condition for Curing.

it was. Although the herrings generally were of superior quality to those taken in 1884, great difficulty was sometimes experienced by the curers, when the catches were heavy, in getting them properly assorted, which made the work of inspection for the brand more than usually onerous and difficult on the part of the officers. During the height of the season, the requests for having herrings branded were occasionally very urgent, particularly at the five principal stations of Shetland, Wick, Fraserburgh, Peterhead, and Aberdeen, and the Board are satisfied that their officers generally did everything in their power to examine the herrings with as little delay as possible; and further that they performed their various duties in connection with this important work in a way which merits commendation.

Inspection for Brand onerous and difficult.

Demands for Branding very urgent at five principal Stations.

How Officers carried out the work.

Table IV. Appendix A, shows the total number of barrels of white herrings which were branded in Scotland last year; and of the brandings in each district. To this table there is added a note showing the total number of barrels therein given, which were branded 'Full,' 'Maties,' or 'Spent'; and the total amount of fees collected.

Particulars of Herrings Branded.

Fraudulent Branding of Herrings.

The legal proceedings instituted in Stettin, on the complaint of the Board, against Mr Alfred Berger, merchant there, which were narrated in their last two Reports, for having fraudulently used a colourable imitation of the official crown brand in branding half barrels of cured herrings under the legal size, have now been brought to a close, and have resulted in the conviction of Mr Berger, who was sentenced to imprisonment. At the trial, Mr Berger urged in defence that he had no intention of doing wrong or injuring any one, and also that the Fishery Board had no public status; and that their brand was not a public one. The President of the court, in summing up the evidence, recognised the public character of the Fishery Board, as proved by documents which the Board had caused to be laid before him, and told the accused party that it was impossible to believe that he did not know he was doing wrong in forging a brand which he had no right to use, and that in doing so he had his own interests in view. At the same time the court seemed to accept the plea that the act was not done with intent to deceive, inasmuch as the herrings were genuine. Taking this view of the case, the President concurred in the demand for imprisonment. The object of the Board in having raised this prosecution has thus been accomplished; and as the proceedings were publicly known, they have no doubt that the conviction obtained will prevent the repetition of such a fraudulent proceeding, which, unless it had been stopped, was calculated not only to diminish the character and worth of the official crown brand, but also injuriously to affect the value of the herring fishery of Scotland. The Board have again to express their obligations to the Secretary of State for Foreign Affairs for the assistance which he kindly gave them in the matter, without which the case could not have been

Prosecution in Stettin resulted in accused party being imprisoned.

Statement of Defender, and of President of the Court.

Object of Board accomplished.

Board's obligations to Foreign Secretary

prosecuted, except under very unfavourable circumstances. It may be added that, besides being imprisoned, Mr Berger has in consequence of these proceedings lost his business and been made a bankrupt.

Consequences to Defender.

ILLEGAL SIZED HERRING BARRELS.

Seizure of Undersized Half Barrels of cured Herrings at Barra.

Notwithstanding the prosecutions instituted by the Board's officers, as narrated in former Reports, for illegal sized barrels having been used for the packing of cured herrings, and the warning given to coopers and fishcurers on the subject, the Board have to report the seizure last year of 60 half barrels of cured herrings belonging to Messrs James Lowden & Co., Fraserburgh, which were under the legal size. This is the same firm against whom the Board took proceedings during the preceding year, for using whole barrels which were less than the statutory size. The seizure last year was made at Castle Bay in the Island of Barra, by the Board's officer there, and after trial before the Sheriff at Lochmaddy, at which no defence was made on the part of Messrs Lowden, the barrels and herrings contained therein were condemned and forfeited.

Condemnation and forfeiture thereof.

Illegal Barrels of Herrings detained at Peterhead.

The Board were also under the necessity of ordering the detention of a number of barrels of herrings, belonging to a fishcurer at Portsoy, which were found at Peterhead under the legal size. It appeared, however, upon investigating this case, that the illegality had arisen from inadvertence on the part of the curer and not from any intention to defraud; and as he expressed regret for what had occurred, the Board resolved, under their statutory powers, to release the barrels on condition that a small fine was paid by the party, and that he enlarged them to the standard size, or, if this could not be done, repacked the herrings into proper sized barrels. These conditions having been complied with, the matter was settled accordingly. With the view of preventing a recurrence of similar illegal proceedings, the Board issued instructions to their officers to make known to the curers in their respective districts the result of the prosecution above mentioned, and to urge upon them the necessity of seeing that all herring barrels and half-barrels made by their workmen were of the full size, namely: that every barrel shall be capable of containing twenty-six gallons and two-third parts of a gallon imperial measure, being equal to thirty-two gallons English wine measure, and that the capacity of every half-barrel shall be one half of a whole barrel. The Board desire to add that they hope to be spared the painful duty of instituting like proceedings again.

Released on certain conditions being complied with.

Instructions to Board's Officers.

Legal size of Barrels and Half-barrels.

HOOPING OF HERRING BARRELS.

Trade petition Board that Herring Barrels may be hooped with either Wooden or Iron Hoops.

The Board, during the course of last year, received petitions from the Herring Trade at some of the principal fishing stations in Scotland, regarding the hooping of herring barrels. Under the regulations then in force, it was not lawful to hoop barrels, for the packing, shipping, or exporting of cured white herrings, with any but wooden hoops, and the prayer of the petitioners was that an additional regulation be passed, making it optional to hoop such barrels either with wooden or iron hoops. The reasons urged by the petitioners

Reasons urged for change.

for this additional regulation being made were, that an unlimited supply of iron hoops could at all times be obtained, whereas the supply of wooden hoops was sometimes quite inadequate for the extended development of the herring trade; and also that barrels hooped with iron could be made much stronger and more easily tightened than those in use at that time, while their cost would probably be less. The Board had no power to comply with the prayer of the petitioners; but after giving full consideration to the views expressed by them, and having received reports from their district officers on the subject, in which a general expression of opinion was given that the desired change would be for the benefit of the trade, they resolved to apply to the Secretary of State, to get inserted in the Sea Fisheries (Scotland) Amendment Bill, 1885, which was shortly after introduced into Parliament and passed, a clause giving them such statutory power as would enable them to do what was wished. They have now the pleasure of reporting that their request was complied with. The clause in the Act is of the following tenor:—'Notwithstanding anything contained in section 'forty of the Act passed in the session of the 48th year of His 'Majesty King George the Third, chap. 110, it shall be lawful to 'pack, ship, or export cured white herrings in barrels made in such 'manner and of such materials, and with such hoops as may be 'approved by the Fishery Board, who are hereby empowered to 'make regulations on the subject, and from time to time to alter the 'same.' The Board thereafter made additional regulations which are now in force, under which every barrel or half-barrel for cured herrings may be hooped entirely with wooden hoops, entirely with iron hoops, or partly with wooden and partly with iron hoops.

Board get Statutory Power to do what is wished.

Additional Regulations made by Board now in force.

HERRINGS EXPORTED.

The total quantity of cured herrings exported in 1885 amounted to 1,128,589½ barrels, which, although a decrease on the previous year of 56,631 barrels, was the second largest exportation of cured herrings which was ever made from Scotland in any one year.

Number of Barrels Exported in 1885, second largest exportation ever made.

From the following table it will be seen that Germany and other places on the Continent got 44,251 barrels, and Ireland 12,588½ fewer, respectively, than in the previous year, but that places out of Europe got 208½ barrels additional:—

Barrels of Cured Herrings Exported in 1885.

Exports of 1885 and 1884 compared.

Years.	To Ireland.	To the Continent.	To Places out of Europe.	Total Number of Barrels Exported.
1884,	35,299½	1,148,956½	964½	1,185,220½
1885,	22,711	1,104,705½	1,173	1,128,589½
Increase in 1885,	...	...	208½	...
Decrease in 1885,	12,588½	44,251	...	56,631

Particulars of Barrels Exported.

Table V. Appendix A, shows the total number of barrels of white herrings exported from Scotland last year; distinguishing the export to Ireland, to the Continent, and to places out of Europe; and distinguishing also herrings cured gutted from herrings cured ungutted, and herrings bung-packed from herrings repacked. To this table is appended a supplementary note showing the ports or places on the Continent to which the herrings were exported; and the total quantities exported.

Places to which Exported.

Yearly totals of Herrings, 1809–1885.

Table VI. Appendix A, gives an abstract of the total quantity of white herrings cured, branded, and exported, year by year, *in so far as brought under the cognizance of the fishery officers,* from 1st June 1809 to 31st December 1885; distinguishing the export to Ireland, to the Continent, and to places out of Europe.

Russian and German Import Duties on Cured Herrings.

Russian Duty on cured Herrings increased and proposal to raise German Duty.

Prosperity of Scottish Herring Fishery largely dependent on Continental demand for cured Herrings.

Number of Barrels Exported.

Injurious effect of increased Duties.

Action taken by Board.

In the month of February last year the Board were informed that it had been proposed to increase the import duties in Russia and Germany on salted herrings from this country, and, on inquiry being made, it was found that an increased duty had already been imposed by the Russian Government. The prosperity of the Scottish herring fishery is very largely dependent on the demand for cured herrings on the Continent. The last returns which the Board had collected, when this matter was being inquired into, showed that the gross export of cured herrings from Scotland to the Continent, amounted in the year 1883 to 863,644½ barrels, being about two-thirds of the whole of the herrings which were cured in Scotland. Of these barrels there were sent to Russian Ports 112,762¾ or fully one-eighth of the gross exports, while in addition it was understood that about 300,000 more were forwarded to Russia through Germany. 750,128½ barrels were sent to Germany direct, and 753¼ to other places on the Continent, making the gross import from Scotland to the Continent, as already stated, to be 863,644½ barrels. The former import duty on salted herrings to Russia was about 4s. 8d. per barrel. It is now about 7s. or one-half more. The Board were very strongly impressed with the injurious effect which such an increased duty was likely to have upon the prosperity of the fishing industry of Scotland, which it may be again stated gives employment to about 50,000 fishermen and boys, and to about the same number of other persons who are occupied in curing the fish and making herring barrels, &c.; while the number of boats engaged is about 15,500. Further, as showing the great importance with which this action on the part of Russia was viewed by the trade, deputations from the principal fishing centres in Scotland waited upon the Board, and urged that Her Majesty's Government should be asked to endeavour to get the additional duty repealed or at least modified. The Board brought the whole subject under the notice of the Secretary of State for the Home Department, and at his instance the Secretary of State for the Foreign Department, instructed Sir Edward Thornton, Her

Majesty's Ambassador at St Petersburg, to invite the attention of the Russian Government to the increased import duty which had been imposed. Sir Edward Thornton stated in reply that, although considerable injury was likely to accrue to the prosperity of the Scottish herring fishery in consequence of the new duty, this country had no special tariff arrangement with Russia; and that H.M. Government could claim no more, as a matter of right, than the treatment of the most favoured nation; but that as the new arrangement appeared to consist of an assimilation of the duties on salted herrings with that formerly imposed on *smoked* herrings only; and inasmuch as the latter involved more expense in preparation than the former, and is consequently of more value, he had, as directed by the Foreign Secretary, pointed out to the Russian Government the apparent injustice of making no distinction between them, and expressed the hope of H.M. Government that the Imperial Government would consent to re-consider the increased duty which was being levied on *salted* herrings. To this communication an answer was received from the Russian Government, in which it was stated that the measure was taken for the purpose of increasing the Revenue; that the duty was not more than 15 per cent. on the price of the herrings; and that a revision of the recent increase of duties could not take place, seeing that it was consequent upon supreme orders. The Board deeply regret that their representations on this important matter should not have been attended with success. With reference to the duty on cured herrings imported into Germany from Scotland, which, as already stated, amounted in 1883 to 750,128½ barrels, the Board were informed that a representation had been made to the German Parliament, to increase such duty from 3s. to 11s. 6d. per barrel. The Board could not believe that so large an increase would actually be imposed by the German Parliament, but it was greatly feared that at least some addition to the duty would be made. They therefore submitted to the Secretary of State that the Foreign Office should also be communicated with on this matter, suggesting that the British Ambassador at Berlin should be asked to watch over what action, if any, might be taken there in the direction feared, and to do what lay in his power to prevent the present duty being raised. This request of the Board was complied with, and they have much satisfaction in being able to add, that according to the latest advices from Berlin, there does not appear to be any change in contemplation in the present rate of duty.

Russian Government's attention called to increased Duty by H.M. Ambassador at St Petersburg.

Result thereof.

Proposal as to increasing Import Duty in Germany.

British Ambassador at Berlin communicated with.

Position of matters.

WINTER HERRING FISHERY.

The winter herring fishing of 1885 was more productive than that of any former season. It was prosecuted to a greater or less extent at nearly all the stations upon both the east and west coast, and during the last two months of 1885 large shoals of herrings were discovered at places where they had never been seen before. This was especially the case as regards the coast of Aberdeenshire;

Fishing more productive than in any former Winter.

Large Shoals on Grounds for first time.

while the Moray Firth, and all the waters northwards to the Pentland Firth, contained herrings in far greater abundance than had been found in any former winter, and very heavy takes were frequently landed. At the close of 1885 prices fell as low as from 1s. to 5s. a cran, and sometimes considerable quantities of fish had either to be made into manure, or thrown back into the sea. The fishermen were so much discouraged by their inability to sell their takes at remunerative prices, that many of them gave up the herring fishing, and prosecuted line fishing instead. The districts upon the East Coast, where the winter herring fishing was most extensively carried on, were Leith, Anstruther, Buckie, Findhorn, Cromarty, Helmsdale, Lybster, and Wick. The catch in all these districts was above the average of recent winters. At Anstruther the quantity of herrings landed showed the greatest increase, and amounted to no less than 40,636 crans, being 29,016 crans above the average of the preceding ten years. In the upper reaches of the Firth of Forth herrings were plentiful in the months of January and February, but in the end of November and December scarcely any could be got. Upon the West Coast the most important winter fishing was in Ballantrae, Greenock, Inveraray, and Campbeltown districts. It was, however, prosecuted to a greater extent at Ballantrae than at all these other places put together. The catch in that district amounted to upwards of 27,000 crans. The prices received for these herrings were generally exceptionally low, although the quality of the fish was fairly good.

Heavy Takes.

Prices very low, and Fishermen gave up Herring Fishing and prosecute Line Fishing.

Most productive Districts.

Anstruther District exceptionally abundant.

West Coast Fishing.

Ballantrae.

Prices very low.

COD, LING, AND HAKE FISHERY.

The cod, ling, and hake fishing was abundant in 1885. The quantity of fish cured amounted to 125,352½ cwts. dried, and 7100 barrels pickled, being an increase on the former year of 846 cwts. dried, and 1192½ barrels pickled. Of the quantity cured dried, 14,469 cwts. were cured on board of vessels, showing a large decrease as against that of 1884, and not being one-half of the average of the preceding twenty years. This branch of the fishing industry is gradually falling off—fewer vessels being now fitted out for its prosecution than was formerly the case, and only seven having gone to Faroe and Iceland last year. At both of these places the enterprise was attended with a fair amount of success. When facilities for sending off the fish quickly were available, large quantities were forwarded in a fresh state to the various home markets. The season produced more than an average catch, and had it not been that very low prices prevailed, the results would have been highly satisfactory to those engaged in the work. The most important stations for this fishing are Shetland, Orkney, and Stornoway. Shetland station produced nearly one-half of the total quantity cured at all the other stations in Scotland. The grounds lying contiguous to these three districts abound with cod and ling, and it is unfortunate that this fishing is not more extensively carried on.

Fishing abundant.

Returns of 1885 as against 1884.

Quantity cured in Vessels decreasing.

Principal Stations.

Rich Fishing Grounds.

The total quantities of cod, ling, and hake cured and exported in 1884 and 1885 respectively, were:—

Total Quantity of Cod, Ling, and Hake Cured and Exported in 1885.

Cod, Ling, and Hake cured and exported in 1884 and 1885.

Cured.			Exported all Cured Dried.			
Years.	Dried.	In Pickle.	To Ireland.	To the Continent.	To Places out of Europe.	Total Quantity Exported.
	Cwts.	Barrels.	Cwts.	Cwts.	Cwts.	Cwts.
1884, ...	124,506½	5,907½	35,126½	11,633	9,956¾	56,716¼
1885, ...	125,352½	7,100	30,144	6,689	10,408	47,241
Increase in 1885, . .	846	1,192½	...	...	451¼	...
Decrease in 1885, . .	...	...	4,982½	4,944	...	9,475¼

Although the gross quantity of these fish cured was quite equal to that of the preceding season, a gradual decrease in the quantity exported has been going on for several years. This was partly owing to the differential duties charged in Spain, which had the effect of reducing the shipments to the Spanish markets. The Board are glad to observe that the proposed commercial treaty with Spain, which gives this country the benefit of the most favoured nation clause, is making satisfactory progress.

Cod, Ling, and Hake cured on Board of Vessels.

Table I. Appendix B, shows the number of vessels fitted out in Scotland last year for the cod and ling fishery; the districts from which they were fitted out; the tonnage of the vessels; and the number of men; also the quantity of cod, ling, and hake cured on board.

Cod, Ling, and Hake cured on Shore.

Table II. Appendix B, shows the total quantity of cod, ling, and hake taken at the cod and ling fishery in Scotland last year by open boats, and cured on shore, distinguishing the fish cured dried and the fish cured in pickle; and distinguishing also the districts in which they were cured.

Total of Cod, Ling, and Hake cured on Board of Vessels and on Shore.

Table III. Appendix B, shows by districts the total quantity of cod, ling, and hake taken, both by vessels and by open boats, at the cod and ling fishery in Scotland, and cured last year; distinguishing the fish cured dried and the fish cured in pickle.

Cod, Ling, and Hake Exported.

Table IV. Appendix B, shows the total quantity of cod, ling, and hake exported from Scotland last year; the quantities thereof exported from different districts; distinguishing the export to Ireland, to the Continent, and to places out of Europe; and also whether cured dried or cured in pickle.

Table V. Appendix B, gives an abstract of the total quantity of

Yearly totals of Cod, Ling, and Hake Cured and Exported, 1820–1885.

cod, ling, and hake cured, punched, or branded and exported, year by year, *in so far as brought under the cognizance of the fishery officers*, from 10th October 1820, when the system for the encouragement and improvement of the cod and ling fishery commenced, to 31st December 1885.

OYSTER, CRAB, LOBSTER, AND MUSSEL FISHERIES.

These Fisheries since Act of 1868, under Board of Trade.

The oyster, crab, lobster, and mussel fisheries, since the passing of the Sea Fisheries Act of 1868 (subsequently amended by the Act of 1877, 40 and 41 Vict. cap. 42) were, until 1885, under the charge of the Board of Trade. One of the purposes of the Act was to encourage the cultivation and increase the supply of oysters and mussels, by authorising the Board of Trade to issue an order conferring a right of 'several oyster and mussel fishery,' on such persons as might choose to apply for it, within a certain specified area of the shore and bed of the sea, or of an estuary or tidal river. Within these limits the Act declared that the order should operate as a grant of the exclusive right of depositing, propagating, dredging, and fishing for and taking oysters and mussels; but practically it proved a dead letter in Scotland. The whole expenses connected with the obtaining of the Order, including the cost of preliminary survey of the portion of the coast to be appropriated, had to be borne by the promoters, who, naturally enough, were unwilling to incur so serious an outlay for the purpose of obtaining permission to engage in an experiment, the success of which was both uncertain and precarious. By the 11th section of the Sea Fisheries (Scotland) Amendment Act, 1885, which has now come into operation, all the powers and duties of the Board of Trade, under the Sea Fisheries Acts and the Acts of 1877 and 1881, so far as they can be exercised in Scotland, in respect to the oyster and mussel fisheries, the crab and lobster fisheries, and the clam and bait beds, have been transferred to this Board, who are now therefore in a position to receive and consider any applications that may be made to them by persons desirous of cultivating the oyster and mussel fisheries, and to afford every facility for their doing so.

That Act intended to encourage cultivation of Oysters and Mussels.

Practically failed to do so.

Powers in Scotland transferred to Fishery Board.

Great falling off in supply of Oysters.

The present state of the oyster fishery of Scotland presents a very striking contrast to the continued prosperity and development of her other fisheries. In former times many parts of the coasts yielded large supplies of excellent oysters, but year after year the falling off in this fishery has been very great, and now the produce is so small that, at least in a commercial point of view, it is of little importance. Last year this decrease still continued. The Firth of Forth, whose waters used to be so famous for the abundant supply of fine oysters which they produced, only yielded in 1884 oysters of the small value of about £500, but last year the whole fishing was worth the much smaller sum of £273. Again, the oysters taken on all the coasts of Scotland in 1885 only numbered 2202 hundreds, valued at £809, as against 5176 hundreds in 1884, valued at £2174. It is, therefore, to be hoped that the passing of the Act in question will have the effect of

Particulars thereof.

Hoped that supply will now be increased.

greatly increasing the supply of oysters and mussels by inducing individuals or companies to engage in their cultivation.

The Board of Trade, when the powers as above narrated were transferred to this Board, had under their consideration an application which had been made to them by the Tayport Mussel Company, which consequently fell to be dealt with by this Board. It was for an Order under the Sea Fisheries Act, 1868, for the establishment of a 'several oyster and mussel fishery' on the foreshore of the Firth of Tay near Tayport, and the Company applied for a further Order for the regulation of an oyster and mussel fishery below low water mark at the same place. These two applications were proposed to be dealt with by one Order; and upon such Order being advertised in terms of the statute, objections to its being granted were received from certain fishermen of Broughty Ferry, and other persons. Thereafter, acting upon an appeal from these fishermen, the Police Commissioners of Broughty Ferry made an application to the Board for a grant of similar powers over the same area. With the view of endeavouring to settle the matter in a way that would be satisfactory to both parties, the Board asked that representatives of their number should be sent to confer with them on the subject. A conference afterwards took place, when it was generally agreed that the two applications which had been made for an Order should be withdrawn, and that a new one, regarding which both parties could agree, would be substituted. No application for such new Order has as yet been received.

Two applications for Oyster and Mussel Fishery in Firth of Tay.

Proposal for satisfactory settlement of matter.

From inquiries which the Board made through their officers and other persons, they learned that the provisions of the Fisheries (Oyster, Crab, and Lobster) Act, 1877, forbidding the taking and selling of undersized and immature crabs and lobsters, were infringed in certain parts of Scotland. They therefore, in order to carry into effect the statute regarding these shell fish, prepared a placard setting forth in plain terms what the law is, and giving notice that all persons contravening its provisions would be prosecuted. In the placard it was stated that by the above mentioned Act it is provided that—

Sale of immature Crabs and Lobsters.

Action of Board to make law known and enforce its provisions.

Section 8.—A person shall not take, have in his possession, sell, expose for sale, consign for sale, or buy for sale,—

(1.) Any edible crab which measures less than four inches and a quarter across the broadest part of the back; or

(2.) Any edible crab carrying any spawn attached to the tail or other exterior part of the crab, whether known as 'berried crab,' 'seed crab,' 'spawn crab,' or 'ran crab,' or by any other name; or

(3.) Any edible crab which has recently cast its shell, whether known as 'caster,' 'white crab,' 'white-footed crab,' 'white-livered crab,' 'soft crab,' 'glass crab,' or by any other name.

Sizes under which Crabs and Lobsters shall not be taken or sold.

Every person who acts in contravention of this section shall be liable to a fine not exceeding £2 for the first offence, and £10 for the second and every subsequent offence, and to forfeit all edible crabs exposed for sale, consigned for sale, or bought for sale in contravention of this section; provided that a person shall not be guilty of an offence under this section if he satisfies the court that the edible crabs found in his possession or alleged to have been sold, exposed for sale, consigned for sale, or bought for sale, were intended for fishing.

Section 9.—A person shall not take, have in his possession, sell, expose for sale, consign for sale, or buy for sale, any lobster which measures less than eight inches from the tip of the beak to the end of the tail when spread as far as possible flat.

Every person who acts in contravention of this section shall be liable to a fine not exceeding £2 for the first offence, and £10 for the second and every subsequent offence, and to forfeit all lobsters found in his possession, sold, exposed for sale, consigned for sale, or bought for sale in contravention of this section.

This placard the Board caused to be posted up in suitable places on the coast; and further, they instructed their officers to exercise vigilance in seeing that no undersized crabs or lobsters were sold in future, and they have no doubt that these fisheries will be benefited from the action thus taken.

FISH SOLD FRESH.

Returns of quantity and value of white and shell fish landed.

In Appendix C. will be found returns of the total quantity and estimated value of the different kinds of white and shell-fish landed in Scotland last year, but excluding those herring, cod, ling, and hake accounted for *as cured* in Appendices A and B; and Appendix C also shows the respective quantities taken in each of the twenty-six districts into which the coasts of Scotland are divided for fishery purposes, with their estimated values.

How collected.

These statistics have been compiled from returns collected by the Board's officers in the twenty-six districts, assisted by a number of correspondents resident at different harbours and creeks. Similar returns for the previous year (1884), were given in the Board's last Report.

Quantity and Value of White Fish landed and sold fresh in 1885, greater than in 1884.

Quantity and Value of Shell-Fish taken also greater.

Although no means existed for comparing the returns of fish landed in 1884 with those in 1883, it was generally believed that the gross yield of 1884 was greater than the average of several years which had immediately preceded it. It is therefore all the more satisfactory to find, by the statistics now presented, that the gross quantity of white fish landed and sold fresh in 1885 exceeded that in 1884 by 331,417 cwts; and further that, although the average prices of fish were much lower in 1885 than in 1884, the value of the catch was £21,529 greater. As regards shell-fish, the quantity taken last year was also greater than in the preceding one, and more valuable by £8254. The gross value of white and shell-fish landed in 1885 was thus £29,783 more than in 1884. With the exception of sprats, mackerel, and tusk, all the white fish taken show a large increase as against 1884, but the greatest increase was in cod, ling, haddocks, whitings, and flat fish. Of shell-fish, there was an increase in the quantity of lobsters taken, but a decrease in oysters, mussels, and crabs.

White Fishing most prosecuted on East Coast.

Of the three divisions into which the twenty-six fishery districts are grouped in Appendix C., viz.:—East Coast, Orkney and Shetland, and West Coast, the white fishing was prosecuted with the greatest energy on the first. This was partly owing to there having been better facilities on the East Coast, for sending fresh fish to the different markets, than in either of the other divisions, and the returns show that the greatest quantity of white fish was captured on that coast.

Quantity of Herrings taken and sold fresh in 1885.

The quantity of herrings taken last year, and sold fresh or lightly salted, amounted to 139,875 crans, being an increase of 1656 crans on that in 1884. Owing, however, to the low range

of prices which prevailed throughout the year, the estimated value was £28,686 less. The districts which sent the largest quantities of herrings to market in a fresh state were Anstruther, Eyemouth, Fraserburgh, and Shetland; but the quantities forwarded would have been much greater than they were, had it not been that the cost of railway carriage was very high—frequently, indeed, twice as much as the fishermen received for the herrings.

The Sprat Fishery.

The sprat fishery yielded 22,426 crans last year, valued at £4190, as against 29,929 crans in 1884, the value of which was £5232. This fishing was prosecuted during the winter months, in the upper reaches of the Firth of Forth, in the Firth of Tay, and in the Moray Firth. It was fairly successful in January and February, but it proved a failure in November and December. The industry was not carried on with much energy, as the prices were low, and the great bulk of the catch could only be disposed of for manure.

The Mackerel Fishery.

The total quantity of mackerel taken last year was 4123 crans, valued at £3995, showing a decrease from 1884 of 766 crans in quantity, and of £1291 in value. The fish were principally got on the West Coast, which yielded 3528 crans, but the fishing of mackerel can scarcely be said to be prosecuted in Scotland, and those landed last year were mostly caught in nets which had been shot for herrings.

The Cod Fishery.

The quantity of cod sent fresh to market last year showed a large increase on the previous year. It amounted to 201,108 cwts., valued at £93,456, as against 144,265 cwts. in 1884, valued at £78,947. All the districts contributed more or less to this increase; but those in which the best fishing was got were Stornoway, Leith, Wick, Anstruther, Eyemouth, Buckie, and Aberdeen.

The Ling Fishery.

The quantity of ling landed and consumed fresh last year was 49,090 cwts., valued at £27,219, being an increase on 1884 of 17,609 cwts. in quantity, and £8723 in value. The districts in which the largest quantities were landed were Leith, Buckie, Wick, and Anstruther.

The Torsk (Tusk) Fishery.

Of torsk (tusk), which are not plentiful on the coasts of Scotland, there were only 531 cwts. sent to market in a fresh state last year, valued at £181, showing a decrease from 1884 of 406 cwts. in quantity, and £194 in value. Of this catch, more than one half was got in Stornoway district.

The Saith (Coal Fish) Fishery.

Saith (coal fish) were taken in greater or less quantities last year on all the coasts of Scotland. The gross weight landed for use in a fresh state was 47,096 cwts., valued at £10,406. This was an increase on 1884 of 7064 cwts. in quantity, and £300 in value. The most productive districts were Shetland, Stornoway, Wick, and Leith.

The Haddock Fishery.

The haddock is the most important of the white fish taken and sold fresh in Scotland, both as regards quantity and value. Last year's haddock fishing was an abundant one, and yielded 522,464 cwts., valued at £304,612, being an increase on that of 1884 of 58,415 cwts. in quantity, and £3900 in value. The districts which contributed most of this increase were Leith, Montrose, Eyemouth, Aberdeen, Buckie, and Anstruther.

The Whiting Fishery.

Of whitings, the quantity caught last year was 99,638 cwts.,

valued at £38,551. This was an increase on the previous year's fishing of 28,131 cwts. in quantity, and £5743 in value. The districts where this fish was most plentiful were Leith, Aberdeen, Montrose, and Eyemouth.

The Turbot Fishery.

Turbot are never got in great abundance in Scotland, but a few are usually taken in most of the districts. The total catch last year amounted to 7350 cwts., the value of which was £13,535, being an increase on 1884 of 3116 cwts. in quantity, and £4167 in value. The districts which yielded the largest quantities were Stornoway, Leith, and Aberdeen.

The Halibut Fishery.

The quantity of halibut taken last year was 28,427 cwts., valued at £20,053, being an increase on the previous year of 5377 cwts. in quantity, and £2429 in value. More than half of the season's fishing was got at Shetland and Orkney, the former having yielded 13,430 cwts. and the latter 2331 cwts. Stornoway produced 4699 cwts. Nearly the whole catch of these three districts was sent to the markets in ice.

The Sole Fishery.

Soles (lemon sole) are found in only a few of the districts. The total catch last year amounted to 5898 cwts., valued at £7486, being greater than that of 1884, by 1735 cwts. in quantity, and £1897 in value. More than one-half of the gross catch was landed at Aberdeen, and there was also good fishing in the districts of Fraserburgh and Montrose.

The Flounder, Plaice, and Brill Fisheries.

The total catch last year of flounders, plaice, and brill amounted to 83,810 cwts., valued at £52,864, being 11,052 cwts., more than in the previous year in quantity, and £5142 in value. The districts which contributed the largest quantities were Aberdeen (in which was got more than one-third of the whole catch), Leith, Montrose, Ballantrae, and Eyemouth.

The Skate Fishery.

Skate are more or less found over all the coast. The quantity landed last year was 106,552 cwts., valued at £15,765. This was an increase on 1884 of 44,570 cwts. in quantity, and £1594 in value. The districts where the best fishing was got were Stornoway (which contributed more than one-half of the whole quantity landed), Shetland, Leith, Buckie, and Aberdeen.

Other White Fisheries.

Of other kinds of white fish, such as bream, gurnard, hake, and cat-fish, the total quantity landed last year amounted to 74,223 cwts., valued at £23,476, showing an increase on the preceding year's catch of 17,750 cwts. in quantity, and £4338 in value.

The Oyster Fishery.

The whole oyster fisheries on the coasts of Scotland yielded only 2202 hundreds in 1885, valued at £809; the preceding year produced 5176 hundreds, the value of which was £2174. During 1885 this fishing may be said to have been prosecuted in only three districts, viz.:—Leith, Stornoway, and Ballantrae, of which the last yielded more than one-half of the gross take of the year.

The Mussel Fishery.

The total quantity of mussels taken in 1885 was 244,262 cwts., valued at £15,367, being a decrease from the preceding year's fishing of 5086 cwts. in quantity, and £695 in value. This decrease may be attributed to herrings having been more largely used instead of mussels for bait in 1885, than in the previous year. The principal mussel scalps are in the Firth of Clyde, the Firth of Forth, the Firth of Tay, the Moray Firth, and in Montrose district, but there are also scalps at a great many other places, particularly on the West Coast.

The Lobster and Crab Fisheries.

The lobster and crab fisheries yielded good returns in 1885. Of lobsters, 956,300 were taken, valued at £35,081; and of crabs, 3,249,900, valued at £23,740, being an increase on the former, as against 1884, of 229,200, but a decrease on the latter of 67,900. The best fishing of lobsters was got in the district of Stornoway, which yielded 522,100, or more than one-half of the gross quantity captured. Orkney produced the next largest quantity, which amounted to 72,800. Lobsters were also found in greater or less abundance in nearly all the other districts of Scotland. Those taken on the West Coast are of finer quality than those got on the East Coast. Of crabs, the Eyemouth district yielded 1,555,000 last year, being about one-half of the entire catch.

Other Shell Fisheries.

Of other kinds of shell-fish, of which the most important are the clam, cockle, whelk, limpet, and razor-fish, 54,196 cwts. were taken in 1885, valued at £14,196, showing an increase on 1884 of 11,950 cwts. in quantity, and £5234 in value. Clams are got in limited quantities in the district of Stornoway, Campbeltown, Inveraray, Cromarty and Orkney; but the most prolific clam bait beds are in Leith district, lying off Prestonpans and Cockenzie, and extending to several square miles. Cockles are found in great abundance upon the West Coast where they are much used as an article of food, and occasionally for bait. The most productive beds are in the Outer Hebrides, especially at the north end of the Island of Barra, where very large quantities of excellent quality have been annually taken for a number of years past, and shipped to various towns in the country, especially in the Midland counties of England, where they readily sell. Since the Highland Fisheries Company's steamer 'Trojan' began her tri-weekly sailing with the mails, that company are purchasing cockles at the different places of call. Thus a more regular market has been found for them than before; and it is gratifying to know that this fishing tended in no small degree to alleviate the poverty which prevailed at Barra during last winter. Whelks are plentiful on many parts of the coast, and large quantities are gathered and sent to market every year. Limpets are also found in considerable numbers in many places, and are regularly gathered for bait. Razor-fish are rarely found except in the sands on the West Coast during low tide. They are sometimes very numerous at Broad Bay, in the Island of Lewis, where they are taken and sold for food.

Increase in Fish taken partly owing to Trawling. Number of Trawlers. Places of delivering Fish.

The considerable increase in the quantity of many food fishes landed during the past year was partly owing to a larger number of beam trawl vessels having been engaged in fishing, 105 having been employed during 1885, as against 61 in the preceding year. Their takes of fish were usually delivered at Berwick, Eyemouth, Newhaven, Granton, Montrose, Aberdeen, and Wick upon the East Coast; and at Ayr and Stranraer on the West Coast.

BOATS AND VESSELS.

Fishing Boats.

Table I. Appendix D, gives an account of the number of boats, decked and undecked, *irrespective* of the places to which they belong, employed in the herring fishery of Scotland, in the season of 1885, in a selected week for each district; with the number of

Boats employed in Herring Fishery in selected week.

fishermen and boys by whom they were manned; of coopers, gutters, packers, and labourers employed at the said fishery in the week so selected; and the total number of all such fishermen and other persons so employed.

Boats and Vessels, Fishermen, and other persons employed in 1884 and 1885.

The following table shows the number of boats, decked and undecked, and beam trawl vessels employed in the herring and other sea fisheries of Scotland; the number of fishermen and boys by whom they were manned; the number of fishcurers, coopers, and other persons employed, in the years 1884 and 1885:—

Years.	Fishing Boats and Beam Trawl Vessels.	Fishermen and Boys.	Fish-curers.	Coopers.	Other Persons (estimated).
1884, . . .	15,445	49,860	1,062	2,809	48,832
1885, . . .	15,532	51,097	1,130	2,806	46,004
Increase in 1885, .	87	1,237	68	...	...
Decrease in 1885, .	...	...	...	3	2,828

Increase in Boats and Fishermen; decrease in other persons.

In connection with the above statistics it may be noted that year after year the number of boats and beam trawl vessels, and fishermen employed in the sea fisheries, continues to increase, thus showing a progressive development of the fishing industry.

Capital employed in 1884 and 1885.

The amount of capital employed last year in boats, beam trawl vessels, nets, and lines, was greater than in 1884. The particulars of this increase are given in the following table:—

Years.	Value (estimated).			
	Boats and Beam Trawl Vessels.	Nets.	Lines.	Total.
1884, . . .	£902,197	£783,589	£117,100	£1,802,886
1885, . . .	923,956	784,726	119,764	1,828,446
Increase in 1885, .	£21,759	£1,137	£2,664	£25,560

Increase in 1885.

Cause of Increase in Capital.

The increase in 1885, shown above, was chiefly due, as in the preceding year, to the additional capital invested in the largest class of fishing boats and beam trawl vessels, which are now so extensively used, with their more expensive equipment and fishing material.

Details of Boats, Vessels, &c., and Capital employed

Table II. Appendix D, shows the number and tonnage of boats, decked and undecked, and beam trawl vessels, employed in the herring and other sea fisheries of Scotland last year, with the districts to which they belong; the number of fishermen and boys by whom they were manned; the number of fish-curers, coopers,

and other persons employed; with the estimated value of boats, beam trawl vessels, nets, and lines.

Table III. Appendix D, shows the tonnage of shipping and the number of seamen engaged in the trade of the herring, and cod, and ling fisheries of Scotland, last year, distinguishing those employed in importing stave wood, hoops, and salt, in carrying herrings or cod-fish coastwise, or exporting them abroad; and distinguishing British from foreign tonnage and men. Tonnage of Shipping and number of Seamen engaged.

The total tonnage of boats and vessels, and the number of persons employed in the herring, cod, ling, and other sea fisheries of Scotland in 1885, as against 1884, were— Tonnage of Boats and Vessels and Persons employed.

Abstract.	Total Tonnage of Boats and Vessels and Number of Persons employed.			
	British.		Foreign.	
Years.	Tons.	Persons.	Tons.	Persons.
1884, . . .	315,914½	114,337	74,817	3,739
1885, . . .	328,802½	113,007	63,534	3,140
Increase in 1885, .	12,888	...	...	...
Decrease in 1885, .	...	1,330	11,283	599

Table IV. Appendix D, gives abstract accounts of the tonnage of vessels and number of men; the tonnage of boats and number of fishermen and boys; and the number of other persons employed in the herring, cod, and ling, and other sea fisheries of Scotland last year. Abstract of Tonnage and Persons employed.

Table V. Appendix D, shows the number of lives lost in connection with the sea fisheries of Scotland; the number of boats totally wrecked, and value thereof; the number of boats damaged, and amount of damage; and the loss on nets and other fishing material lost or damaged, last year. Lives Lost at Sea, and Loss on Boats, Nets, &c.

Building of Fishing Boats and Steam Trawlers.

Owing to the great depression in the herring markets during the last two years, scarcely any fishing boats were built in 1885, with the exception of a few of the largest size, ranging from 50 to upwards of 60 feet keel. Several steam vessels were built for beam trawling and line fishing, as well as for herring fishing, which were fitted up with the most approved appliances. Some fishing boats were recently equipped at Buckie, with engines and capstans for hauling nets, worked by steam power. In view of the Firth of Forth being closed against beam trawling, the General Steam Orders for Fishing Boats. Steam Vessels built for Beam Trawling and other Fishing. Steam power employed for hauling Nets.

Fishing Company (Limited), Granton, so as to be in a position to commence line fishing in these waters, ordered two steam line fishing boats to be built, one of which has been delivered, and the other is expected shortly.

Registration of Fishing Boats as Security for Loans.

Increase in size and cost of Boats.

A matter to which the Board's attention has been called by correspondents and facts emerging in the course of the superintendence of the fisheries by the Board's cruisers, is the impossibility at present of the fishermen being able to raise loans on their boats. In the Board's First Report for 1882 (p. xvi), reference was made to the revolution in the building of herring fishing boats, and the increased value of the sums then invested. While the value in 1862 was estimated at £272,960, in 1882 it had increased to £646,883. As regards the cod and ling fisheries the same Report (p. xxxiv), with reference to Shetland, mentions that 'the six oared 'open boats which were formerly so much in use, are gradually 'being superseded by large decked boats,' which involves the investment of much more capital in boats. Again, in that Report (p. xxxix), the cost of the first-class boats employed in the fisheries was mentioned as having increased from £220 to £300 each.

The Board's Second Report for 1883 again alludes to this increase (p. liv), and states 'that this very large increase is chiefly due to 'the additional capital invested in the large class of fishing boats, 'and beam trawl vessels, which are now being so extensively used 'with their more expensive equipment and fishing material,' and again (p. lvi), that Report states that 'large sized decked boats are in 'great demand. Those built this year measure from 44 to 56 feet 'keel, but some recent orders have been given for boats of even a 'larger size.'

The Board's Third Annual Report, being that for 1884 (p. xlii), shows a still further increase in the capital employed by the fishermen in boats, nets, and lines, the total being upwards of £1,800,000, and the cause is again attributed 'to the additional 'capital invested in the large class of fishing boats and beam 'trawl vessels,' &c.

Under the title 'Boat Building' (p. xliii) it is there stated 'that 'owing to the continued development of the Scottish fisheries, boat 'builders receive a considerable number of orders for new boats during 'the year, and as the fishing is now mainly prosecuted at a much 'greater distance from land than formerly, those chiefly in demand 'are of a large size. The fishing boats in 1884 measured from 44 'to 60 feet keel.'

Deposit of Certificate for Loan worthless.

The most common way in which the fishermen attempt to overcome the difficulty of raising money to prosecute their calling is by depositing their boats' certificates with a bank or other lender to them. Not only is this worthless as a legal security, but the absence of the certificate also renders the boat liable to seizure by the cruisers, and by such seizure the boat is prevented fishing until production of the certificate. Under international obligations it is impossible for the cruisers to allow the absence of the certificate from the boat to pass unnoticed.

So long ago as February 1885 Messrs Johnston & Sons of Montrose directed the Board's attention to this matter. They wrote the Secretary—'There seems to be no provision for mortgaging 'a boat, and consequently the fisherman, when he requires to 'borrow money on his boat, must pay a much higher interest for it 'under present circumstances than he would do if he could grant 'the lender a mortgage. We think the Customs could arrange this 'both as to registration and mortgage. We are quite sure it would 'be a great boon to the fishermen—at once making them more 'independent of the lender, although the lender should happen to 'be a fishcurer. It would save the men from 1 per cent. to 2 per 'cent. interest per annum.'

Loans on Mortgage.

Accordingly, the Sheriff of Caithness, Orkney, and Zetland, a member of the Board, agreed to make inquiries on the subject, and particularly, whether any of the fishermen had registered their first-class boats under the Merchant Shipping Acts. Mr Burnet, the obliging and energetic Collector of Customs at Wick, communicated his views in writing. He reports: 'I have frequently indicated to 'boat owners the advantages arising from registry of their boats 'under the Merchant Shipping Acts. These are, facility of sale and 'mortgage, and what is much needed, security of share owners. 'There is also limited liability for damage caused by collision, 'an important matter, although it is an eventuality not likely to 'be onerous under the present system of construction. Another 'advantage of registry is the removal of the disability under the 'Acts and the Customs Regulations for boats over 15 tons engaging 'in the coasting trade, for which the larger vessels are well adapted. 'The hindrances and drawbacks to registration are practically *nil.* 'The fee of one pound for measurement, and inspection, and the 'provision of lights and fog-signalling apparatus should not operate 'against the many advantages. What I believe to be the chief 'hindrance is the present system of levying harbour dues, and 'the fear of the boats being brought under the usual tonnage 'rates. Three boats only have been registered in order to engage 'in the coasting traffic.' Mr Malcolm McLennan, the Sheriff's Procurator-Fiscal at Wick, also writes:—

Registry under Merchant Shipping Acts.

'Fishermen generally, I believe, would thankfully avail them-'selves of the existing law, by registering their fishing boats as 'British ships, but difficulties intervene which render it impracti-'cable. At this port there is no surveying officer who can admeasure 'the tonnage capacity of a boat. I believe the nearest port where 'a survey could be had is Fraserburgh. Now a voyage to Fraser-'burgh, for the purpose, costs too much money, as crews are seldom 'mustered and boats fitted out before the time has come for the 'commencement of fishing engagements. Last year, having vin-'dicated a fisherman's right to a boat in your Court here, against 'his fishcurer, and the man being due the fishcurer a balance on 'account, I was desirous of registering the boat as a British vessel 'in order to take a small mortgage, but in the absence of a local 'surveyor I had to give it up.' He concludes by recapitulating the objects to be attained by an inexpensive system of registration for fishing boats, thus:—'(1) Giving to the fisherman 'certainty of ownership such as he cannot be deprived of except

'by his own bill of sale, and (2) a means of facilitating the 'obtaining of a loan on the security (of his boat) without parting 'with it altogether. I sincerely trust your Fishery Board will 'secure provisions for the effectual registration of the ownership and of mortgages on all sea fishing boats. I have no doubt 'it would be a distinct advantage to the fisheries. It would give 'the fishermen a sense of security in their floating property similar 'to what they have in their cottages, tend to the increase of care 'and thrift, and so quicken them in their industry.'

Another correspondent, Mr Dickson of Montrose, addressed a letter to the Board on this subject, dated 13th March 1886. He alludes to the methods at present in use for raising money on fishing boats by leaving arrears due to the boat builders or applying to fishcurers for advances repayable by the latter receiving usually 'to account of principal and interest, only the boat's '"deal" or share of the fish caught, a most precarious mode of 'payment. Very large sums have been advanced in this way, but 'it is believed that, for various reasons, curers are becoming more 'chary of making such advances, while the heavy losses recently 'sustained by the curers will prevent many of them from making 'the advances, however willing. Should this prevail to any extent, 'it is quite evident that it will materially affect the fishing 'industry, and ultimately the general public. It need scarcely 'be added that the fishermen themselves would also gladly 'welcome a relief from the present system, and the time appears 'to have now come for giving fishing boats all the advantages and 'privileges of the Shipping Acts, so as to enable the fishermen to 'borrow on the security of their valuable boats by way of mortgage. I trust therefore that you will give this important subject 'your early consideration and take the necessary steps to have the 'above suggestion carried into effect. By so doing, I am satisfied 'you will confer a great boon on the whole fishing community. 'The foregoing remarks are, of course, specially applicable to the 'case of first class boats employed on the East Coast fishings, but 'there appears to be no special reason why the advantages of the 'Shipping Acts should not be extended to boats of the second and 'third class also; and I would further commend the subject for 'consideration in view of the proposed legislation for the benefit 'of the crofter fishermen of the West Highlands. Were the 'crofters entitled to mortgage their boats to private individuals, 'banks or other lenders, the necessity for many small advances 'from the Treasury would be correspondingly diminished, while, if 'the advances are to be made by the Treasury at a low rate of 'interest, there will be a preferable security for them, care being 'also taken to have the boats and their outfit sufficiently insured.'

Promised Legislation.

The Board observe that this matter, which cannot be taken up and dealt with too soon, has lately had attention drawn to it in the House of Commons by Mr Barclay, M.P. for the county of Forfar. Mr Trevelyan, when Secretary for Scotland, is reported to have stated in reply 'that the matter to which the honourable member refers is 'one of great moment to the interests of the fishermen, and the 'Government are carefully considering whether they should not 'introduce a bill to apply to the whole of Scotland constituting a

'register of fishing boats, in so many cases of considerable tonnage, 'and giving over them as good security for a mortgage as over 'small merchant ships.' It is time that the question should be considered and a remedy applied.

MARINE POLICE AND FISHERY SUPERINTENDENCE.

In regard to the Sea Fisheries Act, 1883, and the North Sea Fisheries Convention, it was intimated by the Board of Trade to this Board that they had received a report by Rear-Admiral Gordon Douglas and Mr H. Noel Malan, who had, as mentioned in last year's Report, been appointed to conduct a joint inquiry respecting the measures to be adopted for giving effect to the above Statutes. In that Report they stated that the Act and the Convention appeared to be imperfectly understood by fishermen, if, indeed, in the north they were acquainted with them at all, and they suggested that the chief provisions of these measures should be embodied in plain terms in a placard to be posted up at such places as were frequented by fishermen. A placard was accordingly prepared by the Board of Trade and communicated through the Secretary of State, and this Board, through their officers, got it posted up and circulated in the fishing districts on the coasts of Scotland. Further, this Board, with the concurrence of the Board of Trade, compiled and printed a small pamphlet in a popular form, for the guidance of fishermen on the Scottish coasts, containing a summary of the chief regulations now in force under the Sea Fisheries Act, 1883, and relative Statutes, and supplied their officers with copies of the pamphlet, with instructions to give one to every master or owner of a fishing boat of the 1st or 2nd class in their respective districts. A copy of this pamphlet will be found in Appendix H.

Sea Fisheries Act, 1883, and North Sea Fisheries Convention, imperfectly understood by Fishermen.

Placard and Pamphlet containing chief Regulations prepared and circulated.

By the 5th section of the Sea Fisheries (Scotland) Amendment Act, 1885, it is required that every British sea fishing boat propelled by steam, fishing in any part of the sea adjoining Scotland, shall, in addition to being lettered and numbered in terms of the regulations under the Sea Fisheries Acts and relative Orders in Council, have the letters and numbers painted on the quarter and on the funnel; and it is enacted that it shall be the duty of the Board to enforce the provisions of these Acts and Orders in Council, by directing their officers to use the powers conferred upon sea fishery officers. The Board, in fulfilment of the duty with which they are thus charged, issued a circular to their officers drawing their special attention to this subject, and also containing instructions for carrying the regulations into effect in regard to the lettering and numbering of all sea-fishing boats. They further directed them to make a special inspection of all the beam trawl vessels and fishing boats in their respective districts along the coast, in order to ascertain whether they were properly lettered and numbered in terms of the regulations; and wherever they found any disregard in respect thereto, to warn their owners or masters that, unless the law was strictly observed, it would be their duty to take legal proceedings against them for its enforcement. The officers were also instructed to report the

Board charged with enforcing Regulations as to Lettering and Numbering of Boats.

Steps taken to carry out this work.

Instructions to Fishery Officers.

Officers to report periodically to Board.

result of the inspection to the Board; setting forth, as far as possible, the number of boats whose owners were acting up to the regulations, and of those who were neglecting them; and thereafter to make similar Reports periodically to the Board. They were further directed to keep the Board informed as to what proceedings they might deem it necessary to take, so as effectively to carry out this new and important work. The Board have every reason to be satisfied with the manner in which their officers are giving effect to these instructions, and they trust that the regulations as to the numbering and lettering of boats, will in future be much better observed than has hitherto been the case.

Boats detained in 1885.

The number of boats detained in 1885 for contravention of the regulations in regard to lettering and numbering, was 343, being an increase of 68 on the preceding year.

Registration of Boats.

The work in connection with the registration (for police purposes) of fishing boats, forms also a part of the duty of the Board's officers. The number of applications made to them for certificates of registration during the year 1885 amounted to 752; the number of applications transmitted to Collectors of Customs, and of certificates issued was 749; and the number examined and endorsed 5605, showing a decrease from last year of 148 in the number of applications to register, of 150 in the number of certificates issued, but an increase of 172 in the number of certificates examined and endorsed.

Certificates issued and examined and endorsed.

Prosecution for offences committed at Sea, and as to obtaining compensation for Damage.

The Sea Fisheries (Scotland) Amendment Act, 1885, makes certain important changes upon the law for the prosecution of offences committed by any person against the provisions of the Sea Fisheries Acts, and also as to the mode to be adopted for obtaining compensation for damage caused by such offences. The 7th section of the Act provides that, where an offence has been committed by any person belonging to a British sea-fishing boat in Scotland, or in any part of the sea adjoining Scotland, against the Sea Fisheries Acts, whereby any injury is done by one sea-fishing boat to another, or the nets, lines, or gear thereof, or its apparatus used in fishing, it shall be lawful for any sea fishery officer of the Board, to whom complaint is made by the party injured, to inquire into the complaint, and, after affording the person charged with the offence an opportunity of being heard, to make a report to the Board, setting forth the facts of the case, and the amount of the damage done.

Officers to inquire and report to Board.

Fishermen sustaining Damage should make complaint to Officers.

The Board would therefore strongly recommend any fisherman whose boat, nets, lines, or fishing gear are damaged by any trawler or other fishing boat immediately to make his complaint known to the fishery officer of the district, or to any of the commanders of the superintending cruisers, who will, in terms of the Act of Parliament, inquire into the circumstances of the complaint, and issue a report setting forth the particulars thereof, and stating the amount of damage done, and who is in fault. In the event of both parties being satisfied with the report, the matter may be settled in terms thereof; but if an arrangement is not made, then the injured party may take the case into Court and have the question tried and decided by the Sheriff, the statutory report being part ofthe evidence.

The Board, with the view of assisting their officers to carry out the duty thus imposed upon them, prepared and issued blank forms

of complaint and report; and it is gratifying to state that a number of cases of damage have been settled in accordance with reports made by the officers, without recourse having been had to proceedings in a court of law.

Cases of Damage settled.

Appendix I gives a return of the complaints investigated and reported on by the Board's officers since the passing of the Act in 1885 to the present time, and also of the offences brought under the notice of the Procurator Fiscals of the counties where they were committed for the same period, and showing in what way each case was disposed of.

Return of Complaints investigated and reported on.

The two vessels in the service of the Board, employed in carrying on superintendence at sea during 1885, were H.M.S. 'Jackal,' commanded by Lieut. J. R. Prickett, and who was succeeded in the course of the year by Lieut. J. W. Osborne, with her tender 'Daisy,' and the 'Vigilant' Cruiser, commanded by Mr Alex. M^cDonald. To these vessels were added by the Lords of the Admiralty, during the great East Coast summer herring fishery, H.M. gunboat 'Firm,' Lieut. George Izat in command, H.M. Cutter 'Eagle,' Mr Henry Miller in command, and H.M. Cutter 'Active,' Mr W. Sherlock in command, tenders from the Leith Guard Ship; also H.M. gunboat 'Firefly,' Lieut. Robert Bruce in command, and subsequently H.M. Cutter 'Adder,' Mr Robert Scone in command, from the Hull Guard Ship.

'Jackal' and 'Vigilant' employed in superintendence at Sea.

Also 'Firm,' 'Eagle,' 'Active,' 'Firefly,' and 'Adder.'

The 'Jackal' was employed during the year at Ballantrae on the Ayrshire coast, and at Barra in the Hebrides, and at Wick, while the summer herring fishing was going on. She was also engaged, along with her tender 'Daisy,' in putting down Sunday fishing in Loch Fyne, of which complaints had been made to the Board, and also in stopping disturbances in Glen Luce Bay and in Loch Eil, which arose between the drift-net and seine or circle-net fishermen. In carrying out these duties, the Board found in the commanders of the 'Jackal' efficient and energetic officers. The 'Vigilant' cruiser carried on superintendence in the Firth of Forth, visiting from time to time the fisheries going on in the Moray and Beauly Firths, and investigating claims of damages, which she was frequently instrumental in settling, made by seine-net and line fishermen, against beam trawlers. She afterwards proceeded to the herring fishing grounds in the Hebrides, and continued there until her services were required upon the East Coast for the great summer herring fishery. She was stationed there at Aberdeen, and took charge of the extensive coast between that place and Troup Head in Banffshire. Disturbances having broken out at Wick, between the native fishermen and steam trawlers, which had every appearance of leading to serious consequences, the 'Vigilant,' at the request of the Sheriff of the county, was ordered to proceed to that place, and her commander instructed to put himself in communication with the Sheriff Substitute, with a view of restoring order. Her presence there was of much use, and she was required to remain off the coast for a short time thereafter in case the disturbances should be renewed, which fortunately did not happen. She then returned to the Firth of Forth, where she resumed her duties of superintendence, and was much occupied in enforcing the regulations for the lettering and numbering of fishing boats, and in settling disputes which arose

Services of 'Jackal' at Ballantrae, in Hebrides and at Wick. Also with 'Daisy' in putting down Sunday Fishing and in stopping Disturbances. Valuable services of Commanders.

Services of 'Vigilant.' In Firth of Forth, and in Moray and Beauly Firths. In settling Disputes. In Hebrides. On East Coast.

And at Wick in restoring order by request of Sheriff.

Her further superintendence in Firth of Forth.

Commander's services much appreciated.

between beam trawlers and drift-net and line fishermen. In the performance of these duties, Mr McDonald, her commander, showed great zeal and activity, and his services were much appreciated by the Board.

Services of other Vessels.

'Firm' and 'Eagle' in Shetland and Orkney.

'Active' on East Coast.

'Firefly' and 'Adder' on Northumberland Coast.

Nature and value of their services.

Board's obligations to Admiralty.

In regard to the supernumerary vessels granted by the Admiralty for the protection of the great summer herring fishing, H.M. gunboat 'Firm,' and cutter 'Eagle,' were employed round the coasts of Shetland and Orkney, where large fleets of fishing boats were assembled; H.M. cutter 'Active' was employed between Red Head in Forfarshire and Aberdeen; and H.M. gunboat 'Firefly' and cutter 'Adder,' upon the Northumberland coast. The services of these vessels were of great importance, and the proceedings of their commanders were valuable in carrying out the regulations for the lettering and numbering of fishing boats and vessels, and in settling disputes at sea between the different classes of fishermen. The Board take this opportunity of acknowledging their obligations to the Admiralty for the protection afforded to the fisheries by these vessels, and also for supplying a manual for the guidance of their officers in carrying out their fishery duties, of which this Board have availed themselves for their own officers. It would rather appear that further demands will require to be made on the Admiralty for assistance in carrying out the provisions of the Sea Fisheries Acts.

TELEGRAPHIC EXTENSION TO REMOTE FISHERY DISTRICTS.

New Telegraphic Stations opened.

Amount of guarantees reduced.

Benefits of the Telegraphic Extensions.

Boats brought back from Ireland in time to fish at Barra.

The telegraphic extensions to the fishing stations of Castle Bay in the Island of Barra; St Mary's, Burra, and St Margaret's Hope in Orkney; and Reawick and Vaila Sound (Walls) in Shetland, regarding which particulars were given in the Board's last Report, have been in full operation during the past year. Owing to the fine weather which prevailed when the cables were being laid, the cost of these extensions was less than had been anticipated, and the Postmaster-General, with the sanction of the Treasury, reduced the amounts of the guarantees which the Board gave against loss as follow:—Castle Bay, Barra, from £1095 to £858; St Mary's, Burra, and St Margaret's Hope, Orkney, from £298 to £281; and Reawick and Vaila (Walls) in Shetland, from £281 to £255. It is gratifying to find, from reports which have been received, that these telegraphic extensions have been highly appreciated by fishermen, fishcurers, and others engaged in the fishing industry, and that they afforded them valuable facilities in conducting their operations. As regards Castle Bay, Island of Barra, had it not been for the extension of the wire to that place, very few boats would have been fishing in Barra section last year. Owing to the fears which were entertained that there might be war with Russia, and that the large orders for cured herrings, which are always received from that country, would consequently cease, the fishcurers had engaged beforehand only a few boats for the season. When, however, any danger of war breaking out passed away, there was yet time to engage by telegraphic messages boats from Ireland, where many had gone, and these arrived soon enough

to take part in the fishing. Further, the curers and foreign herring merchants were able, during the season, to have constant communication with each other, and sales of cured herrings on the Continent, and the prices which they realised, were known at Barra as soon as they took place. And, indeed, so many messages were sent while the fishing was going on, that sometimes a stoppage took place in their transmission. At St Mary's, Burra, and St Margaret's Hope in Orkney, the extension has been a great boon to the fishermen, by enabling them to obtain early information as to where shoals of herrings appeared round the different islands, so that they could at once remove to the grounds where they were lying. The wire has also been most valuable, by putting it in the power of fishcurers, when their supplies of salt and barrels ran short at particular stations, owing to the fishing having proved unexpectedly abundant, to get additional quantities quickly from Wick. Formerly, when communications could only be sent through the regular post, several days elapsed before such extra supplies could be obtained, and large quantities of fish caught were often worthless before they arrived; but last season they were got on the afternoon or evening of the same day on which they were ordered. At Reawick and Walls in Shetland, the extension has also been of great advantage to those engaged in the fishing industry, and, altogether, it is a cause of much satisfaction to the Board that these telegraphic wires have been laid.

State of Foreign Markets known daily.

Early information where Herrings appeared.

Additional supplies of Barrels and Salt quickly got when fishing was abundant.

HARBOURS.

Harbours.

In Appendix E will be found a report by the engineers upon the harbour works completed by the Board during the year.

Engineers' Reports.

Since the constitution of the Board on 16th October 1882, they have given assistance in the construction or improvement of the following harbours, viz.:—Rosehearty, Aberdeenshire; Findochty, Banffshire; Ness, Island of Lewis; Crovie, Banffshire; and St Monance, Fifeshire.

Harbours constructed or improved since constitution of Board.

The first two of these harbour works, viz., Rosehearty and Findochty, were undertaken by the old Board, the former having been begun in the summer of 1881, and the latter in the summer of 1882.

The works at Rosehearty included the construction of a breakwater head and outer rock excavation at the west harbour, the erection of a return head at Port Rae Pier, the removal of rock which projected beyond the wall of the breakwater at the west harbour, and the reduction of the height of the rocks at the entrance to Port Rae Pier. These works were all completed in the end of 1882, with the exception of the removal of the shoal at the entrance to Port Rae Pier, for which it was agreed to place £250 at the disposal of the Rosehearty Harbour Board, to be expended as tides and weather permitted. On the works undertaken there was expended by the old Board £1660, 7s. 4d., while the new Board have expended £421, 3s. 3d., making a total expenditure of £2081, 10s. 7d., of which the Rosehearty Harbour Board contributed £500.

Rosehearty.

Total expenditure.

Findochty. The Findochty Harbour Works embraced the erection of a breakwater, the construction of an additional breakwater on the eastern side of the creek, and the erection of a breast wall at its root. Towards the expense of these works, which were completed in 1884, the fishermen of Findochty contributed £3000, while in carrying them out the old Board expended £1913, 7s. 9d., and the new Board £9418, 1s., making a total expenditure of £11,331, 8s. 9d.

Total expenditure.

Ness. Of the three works undertaken by the present Board, the erection of a much-needed harbour at the Port of Ness was the most important. This harbour, which was completed early in 1885, cost £5809, 2s. 2d., of which the trustees of the late Sir James Matheson generously contributed £1500.

Total expenditure

Desirability of Fishermen arranging to keep Harbour in repair. Seeing that the harbour at this place was erected for the benefit of the fishermen of Ness, it is to be hoped that they will make arrangements for clearing the channel of sand should it at any time show a tendency to become silted up, as well as to keep the works in an efficient state of repair.

Benefits from Harbour. It is satisfactory to know that smacks are now plying regularly between Stornoway and Ness, and that the Ness fishermen are now getting a market for their fish not previously available. This is especially the case in regard to halibut, which was used only for bait previous to the erection of the new harbour.

Crovie. At Crovie the Board erected a landing slip for the boats fishing from that creek. The slip was completed in September last, and cost £1225, 0s. 6d., the Crovie fishermen contributing £300.

Total expenditure.

St Monance. The works undertaken by the Board at St Monance comprised the additional excavation of rock in the basins of the east and west harbours, and the widening of the entrance to these harbours. Towards the expense of the works, which amounted to £1839, 18s. 1d., the resident fishermen contributed £500.

Total expenditure.

Above five Harbour Works. On the above five harbour works the Board have thus expended £18,713, 5s., and if to this be added the amount expended by the old Board on the harbours of Rosehearty and Findochty, viz., £3573, 15s. 1d., it will be seen that the gross expenditure on the harbours which the present Board have assisted in constructing or improving, has amounted to £22,287, 0s. 1d., towards which £5800 has been contributed by the different localities.

Total expenditure.

Stonehaven Harbour. The Board are at present in communication with the trustees of the Stonehaven harbour with the view of assisting in the improvement of that harbour, and as the adoption of either of two schemes which have been proposed would involve the expenditure of a considerable amount of money, the Board have, in view of the limited funds placed at their disposal, delayed stating what assistance they would give for the improvement of any other harbours until the negotiations regarding Stonehaven had advanced to such a stage as to enable them to know what funds would be available for other works.

Negotiations for its improvement.

As will be seen from the following list, the number of harbour works which the Board have been enabled to undertake, bears a very small proportion to the number of applications made to them for assistance:—

List of Harbours for which application has been made to the Board for aid in their construction or improvement, none of which they have as yet agreed to assist.

List of harbours for which aid asked, none of which yet assisted.

1. Auchmithie, Forfarshire.
2. Avoch, Ross-shire.
3. Balintore, Ross-shire.
4. Ballantrae, Ayrshire.
5. Banff, Banffshire.
6. Broadford, Island of Skye.
7. Burnmouth, Berwickshire.
8. Cairnbulg, Aberdeenshire.
9. Coldingham, Berwickshire.
10. Cowie, Kincardineshire.
11. Eyemouth, Berwickshire.
12. Fair Isle, Shetland.
13. Foula Island, Shetland.
14. Fraserburgh, Aberdeenshire.
15. Girvan, Ayrshire.
16. Golspie, Sutherlandshire.
17. Inverallochy, Aberdeenshire.
18. Keiss, Caithness-shire.
19. Kinlochbervie, Sutherlandshire.
20. Lochbuy, Island of Mull.
21. Port Errol, Aberdeenshire.
22. Port Hopeman, Elginshire.
23. Portknockie, Banffshire.
24. Portmahomack, Ross-shire.
25. St Andrews, Fifeshire.
26. St Colmbs, Aberdeenshire.
27. Scoraig, Ross-shire.
28. Stonehaven, Kincardineshire.
29. Stroma Island, Pentland Firth.
30. Tyree, Island of Mull.
31. Waternish, Island of Skye.

In the foregoing list are included applications of a very clamant nature, many of the works desired being necessary, not only for the successful prosecution of the fishing industry, but likewise for the safety of those engaged in it.

Applications of very clamant nature.

In considering the relative merits of the applications, however, the limited means at the Board's disposal makes it inevitable that those which can be favourably entertained must be reduced to a very limited number; and thus many applications may have to be rejected, not because the claims for assistance are indifferent, but simply because the Board will not in the circumstances be able to do otherwise.

Funds at Board's disposal admits of few cases being favourably entertained.

In the end of last year His Grace the Duke of Richmond and Gordon, then Secretary for Scotland, requested the Board to have a special inspection made for certain harbours in the Island of Lewis, with the view of reporting to him on the subject, and in accordance therewith Mr Brebner, of Messrs. D. & T. Stevenson, C.E., accompanied by the Secretary to the Board, made the necessary inspection, and afterwards furnished a report thereon to the Board, which was communicated to His Grace.

Inspection for Harbours in Lewis.

In Appendix E is given an account of the sums received and paid by the Board last year for building or repairing piers and harbours, and for telegraphic extension to remote fishery districts.

Sums received and paid for Piers and Harbours, and for Telegraphic extension.

The Board have again had under their consideration the future maintenance and management of the harbours along the coast, to the cost of which they and their predecessors have contributed. It was the practice of the old Board to stipulate that no dues should be charged on fishing boats or fishing vessels entering these harbours. But the better opinion, and that on which this Board would act if they could, is that dues should be levied so as to provide a fund for the future maintenance of

Future maintenance and management of Fishing Harbours.

the harbours, and also that some Local Authority should be appointed to levy dues and to attend to and regulate the affairs of each harbour. The attainment of these desirable objects, by obtaining a special Act of Parliament, is from its expense out of the question. The Board, however, thought that resort might be had to Provisional Orders under the Acts 24 and 25 Vict. cap. 45, and 25 and 26 Vict cap. 19, which were passed in 1861 and 1862 to meet cases of a similar kind. Communication accordingly was opened with the Board of Trade through the Home Secretary, as it is to the Board of Trade that a memorial for the Order has, as the initial step, to be presented. This was necessary in order to ascertain whether they would consider this Board as competent 'promoters' of an Order, and also whether the Board of Trade would insist on the condition, imposed as regards all Provisional Orders in other cases, of this Board's finding security for the Board of Trade's necessary costs, charges, and expenses. Even were the Board of Trade not to insist on this condition, there were other expenses connected with the necessary advertisements and the deposit of plans and a schedule of rates which would fall, in the first instance, on this Board as the promoters, although, as in all other Orders, a clause would be inserted making these expenses repayable as a first charge out of the rates and dues imposed. To the Board's application on the subject, the Board of Trade sent the following reply through the Home Office:—

The Board's proposal to apply for Provisional Orders.

Board of Trade (Harbour Department),
Whitehall Gardens, S.W.,
7th April 1885.

Sir,—I am directed by the Board of Trade to acknowledge the receipt of your letter of the 23rd ult., in which you transmit copy of a letter from the Fishery Board for Scotland relative to the question of fishermen and others locally interested being constituted as harbour authorities for places in Scotland by provisional Orders under the general Pier and Harbour Acts.

In compliance with your request for the observations of this Board in the matter, I am to ask that you will lay the following remarks before Secretary Sir William Harcourt.

The constitution of a harbour authority is one of the objects which may properly be made the subject of an application for a Provisional Order, under the General Pier and Harbour Acts, and the power conferred by these Acts upon the Board of Trade for this purpose has from time to time been exercised in respect of places in Scotland, and other parts of the United Kingdom.

The Board of Trade are, however, only able to exercise this power upon due application made to them, and though always desirous to further any scheme deserving of support, they have no authority to initiate the proceedings for an application. It is therefore difficult to see how the object in question can be attained, in respect of the incorporation as harbour authority at any place, of persons locally interested, unless such persons themselves come forward as promoters, and are prepared to defray preliminary expenses in respect of the application for the Order and of the earlier steps for administering its provisions.

Where an Order is made and confirmed by Parliament, such expenses could eventually be repaid out of the proceeds of any rates leviable under it, and provisions to this effect are commonly included in Provisional Orders. But it is impossible to say whether, in any particular case, an Order could be made, or if made, what its provisions would be, until the requisite statutory notices have been given, and any objections which may be forthcoming have been considered.

The steps to be taken by promoters of Provisional Orders are explained in pages 9 to 12 of the accompanying memorandum, which has been prepared for the information and guidance of persons interested in works on tidal lands. The only charge made by this department to promoters is the fee of £35, mentioned in Regulation 8, at page 11, of the memorandum, which has been fixed in consultation with the Treasury.

Among recent Scottish Orders may be mentioned 'The Port Seton 'Harbour Order 1878,' 'The Fortrose Pier and Harbour Order, 1879,' and 'The Cullen Harbour Order, 1884.'

By these orders respectively harbour authorities were constituted at Port Seton, in the county of Haddington; Fortrose, in the county of Ross; and Cullen, in the county of Banff, and the orders were confirmed by the following Acts of Parliament:—The Pier and Harbour Orders Confirmation Act, 1878 (No. 1), 41 and 42 Vict. cap. 114 (local); the Pier and Harbour Orders Confirmation Act, 1879, 42 and 43 Vict. cap. 55 (local); and the Pier and Harbour Orders Confirmation Act, 1884, 47 and 48 Vict. cap. 216 (local).

'The St Monance Harbour Order 1885,' now awaiting confirmation by Parliament, includes amongst its objects the incorporation of a body of Harbour Commissioners for St Monance, in the county of Fife.

I have the honour, &c.

(Signed) C. CECIL TREVOR.

The Under Secretary of State,
Home Office.

We have printed this letter in full, in order that your Lordship may have before you the view which is taken by the Board of Trade on this question. We need hardly point out that the statutes referred to, and the rules framed for carrying them out, were passed before this Board came into existence; and, as public opinion is now all in favour of local government, we submit that the whole subject should be reconsidered, and that speedily—because, beyond doubt, it is not for the public advantage that harbours, built to a large extent with public money, should be left, after completion, to take care of themselves.

SALMON FISHERIES.

Mr Young's Inspections.

In the course of last summer, Mr Young, under the direction of this Board, inspected the salmon fisheries in the Inner and Outer Hebrides, including the islands of Islay, Mull, Skye, the Lews and Harris, North Uist, Benbecula, and South Uist; the Salmon Rivers belonging to the mainland of Scotland having been previously inspected and reported upon by him in 1883 and 1884, including those on the East Coast from the Forth to the Kyle of Sutherland,

both inclusive; those in Ayrshire and on the Scottish shore of the Solway Firth; and those in the counties of Caithness, Sutherland, Ross and Cromarty, Inverness, Argyll, and Dumbarton. The valuable fisheries in the lochs and streams and around the shores of the Orkney and Shetland Islands still remain to be inspected and reported on. Mr Young's Report on the Salmon Fisheries in the Inner and Outer Hebrides forms Appendix G to this Report, and we have the honour to inform you that the Board approved of it after having given it careful consideration.

Salmon Disease.

The salmon fishings in the Inner and Outer Hebrides appear to be entirely free from the salmon disease, which has manifested itself, at various times during the last ten years, with more or less severity in several of the rivers on the mainland, such as the Tweed, the Tay, the Dee, Don, Deveron, and some of the Ayrshire and Solway rivers. During the past year it has been less virulent than formerly on the Tweed and other infected rivers. The following return shows the number of diseased fish taken from the Tweed and its tributaries, which have suffered more than any other rivers in Scotland from the ravages of the salmon disease during the last five years:—

	1881.	1882.	1883.	1884.	1885.
Salmon, . .	2,372*	11,260	3,919	6,665	2,477
Grilse, . . .	260	1,858	211	951	427
Trout, . . .	187	1,454	673	2,700	621
Totals,	2,819	14,572	4,803	10,316	3,525

This gives a total of 36,034 diseased fish in the course of five consecutive years. But the two first years of this quinquennial period show nearly as great a number of diseased fish (17,391) as the three last years (18,646); and the second year (1882), shows a greater number of diseased fish than 1884 and 1885 put together.

Drawings of Salmon Ladders.

In the beginning of this year Mr Young suggested to the Board that it would be very desirable to have drawings of the most successful salmon-ladders in Scotland, such as the ladder on Deanston dam on the Teith; the pass on Morphie dam on the North Esk; the subsidiary dam on the Girvan at Bridgemill; the ladder which has been constructed to enable salmon to pass round the Falls of the Moriston in Inverness-shire; the two 'Macdonald Fishways' recently erected on the impassable dams at Westfield and Ashbank on the Ericht; and the salmon-ladder now in process of construction at the outlet of Loch Doon. These, with the exception of the last-named, have been fully described by Mr Young in his various Reports to the Board. But mere descriptions, however detailed and accurate, give a very imperfect idea of such works; and it is therefore thought that drawings would be advisable in order to illustrate and explain the descriptions.

Falls of the Tummel.

Colonel Macdonald, of the United States Fish Commission, the inventor and patentee of the Macdonald Fishway, has designed a

* Includes 171 description not taken.

ladder for facilitating the passage of salmon over the Falls of the Tummel, which there is every reason to believe would be entirely successful. But, owing to difficulties with the proprietors of the Falls, there seems at present to be but little prospect of Colonel Macdonald's design being carried into effect, although it would open up 20,000 acres of lochs and 50 miles of rivers to the migratory Salmonidæ, and so immensely increase the productiveness of the Tay by developing new and extensive spawning grounds. Full particulars with regard to the waters which would be opened up by placing an efficient salmon-ladder on the Falls of Tummel will be found in Mr Young's Report to the Board on the subject, dated 4th May 1884. The estimated cost of the Macdonald Fishway on the Falls of Tummel is £344.

Rivers opened up to Salmon in the course of last year. The Ericht at Blairgowrie and the Ballanachist in North Harris.

Two rivers have been rendered accessible to salmon in the course of last year, viz., the Ericht and its tributaries above Blairgowrie, and a small stream termed the Ballanachist in North Harris and the lochs belonging to its basin. Macdonald Fishways have been placed on two impassable dams on the Ericht, and improvements have been made in some other weirs on that river by the Tay District Board, with the consent and co-operation of the manufacturers at Blairgowrie. These dams were inspected by several members of the Tay Board and by Mr Young, on the 21st of October last, and since then it has been stated on good authority that salmon have been seen 10 and 12 miles above the uppermost dam. There are no fewer than 5 weirs on the Ericht at Blairgowrie which have been operated on with the view of enabling salmon to ascend to the upper waters of the Ericht, and also to the Ardle and Shee which unite to form it, and which together have a drainage area of 150 square miles. The lowest weir is just above Blairgowrie Bridge, and the uppermost one at Westfield is about 2 miles farther up the stream. The lowest weir is not a serious obstruction, and it will now be easily passed by the narrow channel which has been made in it, and which concentrates in a limited space the outflow of water over a considerable length of dam.

A wooden shoot has been constructed near the left bank of the river, on the second dam which is about 400 yards above Blairgowrie Bridge. A massive log runs along the crest of this dam, and the notch or sluice-way which has been cut in it for a depth of 6 inches should either penetrate entirely through it, so as to allow a free and direct passage for the fish after ascending the wooden shoot, or if it be objected that this might weaken the dam, then the face of the log should be bevelled off, so as to be at the same angle as the face of the wooden shoot.

The third dam is 1300 yards above Blairgowrie Bridge, and is about 5 feet from water to water. A narrow channel concentrating the water flowing over the dam has been formed in it. Between the two last mentioned dams there are natural falls, or rather rapids, called the Keith, where there used formerly to be a productive and valuable salmon fishery now extinct.

By far the worst obstructions, however, are still farther up the river. They consist of two perpendicular dams—the lowest at Ashbank, being 10 feet in height, and the highest at Westfield,

being fully 13 feet. These obstructions have for long years proved insuperable barriers to the passage of salmon to the 20 or 30 miles of good water above. But now Fishways on the Macdonald principle have been placed upon both of them. These are the first Fishways of the kind ever placed on absolutely impassable obstructions in this country, and it will be highly interesting to watch their effect. The localities were carefully inspected by Colonel Macdonald in the summer of 1884, and the designs for the Fishways were supplied by him. It should be pointed out, in order to show the great economy of material and labour under the Macdonald system of fishway building as compared with other systems, that the ladder at Westfield has a gradient of 4·75 feet horizontal to 1 foot perpendicular, and that the ladder at Westbank has a gradient of only 4 horizontal to 1 perpendicular. On any other system, the gradient would have required to be at least 9 horizontal to 1 perpendicular; that is to say, the Fishway would have required to be twice as long as the Macdonald Fishway. Yet, in spite of their steep gradients, these Fishways worked beautifully when filled with water. There was black water throughout in both of them; while in passes with as steep a gradient on any other system, there would have been a mass of white foaming water which no salmon would have been able to face.

The Ballanachist River.

The other river, with the lochs belonging to its basin, which has been opened up in the course of last year, is the Ballanachist in North Harris, the necessary works having been designed and successfully carried out by Lady Scott's Head Fisherman without the assistance of any engineer. Mr Young inspected the works, then in progress, in the end of last June, and suggested some alterations, which have since been made; and salmon and sea-trout are now able to pass round a fall 20 feet high, and up a steep hill side to Loch-na-Morcha, and a smaller loch connected with it. The fishings thus opened up are to be attached to Tarbert Hotel; and Mr Hornsby, the landlord of that hotel, on the 27th January 1886, writes as follows to Mr Young respecting the works:—'About the Ballanachist work, it has turned out a complete success. In one cut in the river near the middle, inspected by you and altered as you suggested, there were counted 57 salmon ascending in half an hour. Two of that number were washed on the bank by the force of the stream. We are still engaged in altering the bed, so as to make it more easy for the fish. The lower pool, also suggested by you, is a most complete success. Had I allowed the river and lochs to be fished, I am certain we would have taken over 500 salmon. The river at one time got low, and left 23 salmon high and dry. We secured them, and took them up in tanks to the upper loch (Loch-na-Morcha).'

The past Fishing Season.

The past fishing season has been a successful one, though not quite equal to that of 1883, when 35,506 boxes of salmon were sent to London from Scotland. Next to 1883, it is, however, the best season since 1874. The total number of boxes sent to London was 30,362, and the following summary, kindly furnished by Messrs Forbes, Stuart, & Co., of London, will show the number sent during each week of the season:—

A Summary of the Number of Boxes of Salmon received at Billingsgate Market from Scotland, during the year 1885.

Week ending	No. of Boxes.	Week ending	No. of Boxes.
Feby. 7, . .	62	Brought forward,	6681
,, 14, . .	234	June 13, . .	622
,, 21, . .	386	,, 20, . .	863
,, 28, . .	197	,, 27, . .	1323
March 7, . .	290	July 4, . .	1800
,, 14, . .	175	,, 11, . .	2202
,, 21, . .	254	,, 18, . .	2438
,, 28, . .	268	,, 25, . .	2630
April 4, . .	347	August 1, . .	2436
,, 11, . .	311	,, 8, . .	2645
,, 18, . .	414	,, 15, . .	3192
,, 25, . .	513	,, 22, . .	1811
May 2, . .	597	,, 29, . .	1009
,, 9, . .	581	Sept. 5, . .	413
,, 16, . .	516	,, 12, . .	249
,, 23, . .	537	,, 19, . .	22
,, 30, . .	456	,, 26, . .	26
June 6, . .	543		
		Total,	30,362
Carry forward,	6681		

An attentive observation of the above table will show that the fishing in the close of the season was unusually good, nearly two-thirds of the salmon captured having been taken during the months of July and August; the best week was that ending on the 15th August, when no fewer than 3192 boxes were received at Billingsgate, or more than a tenth of the whole number for the year. Taking the number of boxes sent to London for 1885 at 30,362, and adding one-third for the consumption in Scotland and for salmon sent elsewhere out of the country, the value of the whole take may be estimated at £323,851.

Large Salmon of 1885.

A great number of large salmon were captured during 1885 both by net and rod. On the Tay, salmon of 56 lbs., 55 lbs., 54 lbs., 53 lbs., 52 lbs., 51½ lbs., 50 lbs., and 49 lbs. were taken by the nets, and a very large number between the last mentioned weight and 30 lbs. More than 50 salmon, averaging 45 lbs. each, are estimated to have been taken during the month of August. The largest fish taken by the rod was captured on the Stobhall water, and weighed 47 lbs.; but a great number were caught by anglers on various stretches of the river upwards of 30 lbs. weight. On the Forth the largest salmon netted weighed 47 lbs., and the two largest captured by the rod weighed 38 lbs. and 36 lbs. A great number of fine salmon were taken on the Aberdeenshire Dee, which yielded the largest fish of the season to the rod, weighing 57 lbs. It was captured by the keeper on the Ardoe water.

Rod Fishing on Dee and Tweed.

No fewer than 6000 fish are said to have been taken by the rod on the Aberdeenshire Dee during the season of 1885; and when it is considered that at least 10,000 fish were taken by anglers in the course of the two previous seasons, it may be doubted whether any salmon river in Europe can show a better return. On the Tweed, although we have no accurate returns, there seems little doubt that at least 4000 fish have been captured by the rod, and

the anglers on the Tay have also had a good time of it. But we are unable to give the returns.

Rental of Tay.

The rental of the Tay from 1828 to 1882, both years inclusive, has been already given in Mr Young's Report of 1883 to the Board on the Salmon Rivers on the East Coast of Scotland. The rentals for the subsequent fishing seasons are as follows :—

1883.	1884.	1885.
£17,773 2 0	£19,655 14 5	£20,437 0 2

Loch Tay.

In the same Report a tabular account is given of the salmon fishing in Loch Tay from 1870 to 1882, both years inclusive. The following table brings it down to the end of the fishing season of 1885 :—

Year.	Number of Salmon.	Aggregate Weight in lbs.	Average Weight in lbs. and oz.	Monetary Return.
1883	491	9679	19 11	£710 0 0
1884	240	4710	19 10	641 0 0
1885	398	8617	29 8	484 0 0

Loch Leven.

On Loch Leven—certainly the most remarkable trouting loch in the United Kingdom, whether we consider the number of fish annually killed by the rod, or their size and quality—the fishing season of 1885 has been a very good one, 16,558 trout, weighing 14,434½ lbs., having been taken by the rod. The best month was June, when 5540 trout, weighing 4412 lbs., were captured. The heaviest single trout of the season weighed 3 lbs. 14 oz.; and the heaviest fishing in a single boat was 49 trout, weighing 53 lbs. If we take the seasons of 1883, 1884, and 1885 together, we find that 46,354 trout, weighing 40,714 lbs., or upwards of 18 tons, have been taken by the rod from this singularly productive loch.*

Usk and Shannon.

In England the most productive river for rods has been, as usual, the Usk, 1759 fish, weighing 19,233 lbs., or an average of 10·94 lbs. each, having been captured by anglers. In Ireland the season on the Shannon was a good one, a number of fish between 30 lbs. and 44½ lbs. having been landed by the rod. One gentleman has favoured us with the returns of his spring fishing on three-quarters of a mile of water near Limerick, from which it appears that he caught 28 fish weighing 663 lbs., or an average weight of fully 21½ lbs.—certainly a remarkable average.

Disposal of clean Salmon taken from poachers during the Annual Close Time.

A difficulty of a peculiar kind with regard to the annual close time was recently brought under the notice of the Board. It is thus stated, in a letter to Mr Young, dated 23rd Jan. 1886, by the Clerks to the District Boards of the rivers Dee and Don :—'We 'desire to bring under your notice a difficulty in regard to the 'statutory close time, which we have frequently met with, and 'with which we had to deal so lately as yesterday. The river 'watchers occasionally come upon gangs of poachers, with salmon 'in their possession, during the winter months; and while they

* The remarkable and sustained productiveness of Loch Leven is undoubtedly due, to some extent at least, to artificial fish culture, as, between 1875 and 1884, no fewer than 396,000 artificially hatched trout-fry were put into it; and in one of these years (1882) 3000 two-year old trout were placed in the lake.

'generally succeed in capturing the fish and the poaching implements, it is somewhat rare, owing to the organisation amongst the 'poachers, to secure them, or even to succeed in identifying or distinguishing them to the extent necessary for founding a prosecution. One of these cases occurred the other day on the Don, and 'several times last winter. When the fish are foul, there is of 'course no difficulty in dealing with them; but in this case there 'were twelve all perfectly clean, which it seemed a pity to destroy 'or bury. Although we were not actually aware of any powers he 'had in the matter, we applied to Sheriff Dove Wilson by a petition 'setting forth the circumstances, and asking his warrant to transmit 'them to London for sale—the proceeds to be applied to the uses 'of the Fishery Board. The Sheriff, as we had foreseen, declined 'to grant such a warrant, saying that no authority from him could 'legalise an illegal act, and we are therefore compelled to destroy 'a number of wholesome and valuable fish. We venture to suggest 'that—in view of a continually recurring circumstance like this—'it might be advisable, in the event of any new Salmon Fishery 'legislation, to make some carefully-guarded provision for such a 'case (applicable to Fishery Boards alone) as an exception to § 21 'of the Act of 1868.'

On receiving this letter Mr Young wrote to the Clerks to the Tay District Board to inquire what was their practice in such cases, and received for answer that 'Our practice is to distribute good fish 'so seized among the Infirmary and other charitable institutions.'

It is obvious that, as the law at present stands, the clean as well as the foul fish taken from poachers during the annual close time must be destroyed. The prohibition against selling or using is absolute. The 21st section of the Salmon Fishery Act of 1868 imposes a penalty upon 'Any person who shall buy, sell, or expose 'for sale, or have in his possession any salmon' during the annual close time. It might possibly, however, be worth considering, in the event of any future legislation, whether power might be given to District Boards to sell clean salmon taken from poachers, and apply the proceeds for the protection of the river, and for that purpose only. It would be a sort of retributive justice on the poacher to employ the proceeds of his illegal fishing in putting a stop to such fishing for the future, though practical difficulties might possibly present themselves in giving effect to the suggestion of the Dee and Don District Boards.

Alterations of Bye-laws.

Since the Bye-laws fixing Fishery Districts, Estuaries, Annual Close Times, &c., were published along with the Salmon Fishery Acts of 1862 and 1868, considerable changes have taken place, owing to new Fishery Districts having been formed, and the Annual Close Times of a number of rivers having been altered by Orders under the hand of the Secretary of State, in virtue of the powers conferred upon him by the 9th section of 'The Salmon Fisheries (Scotland) 'Act, 1868.' These alterations were all duly published in the *Edinburgh Gazette.* But as that paper is not generally accessible, it has been judged advisable to publish them in a separate form, and they will accordingly be found collected in Appendix G, No. II., drawn up by Mr Young.

ESTIMATED PRODUCE AND VALUE OF THE SEA AND SALMON FISHERIES OF SCOTLAND.

The total estimated produce and value of the Sea and Salmon Fisheries of Scotland, for the year 1885, are as follow:—

Cured Fish.

CURED FISH—

	£	s.	d.
Herrings, 1,572,952¼ barrels, at 20s. per barrel,	£1,572,952	5	0
Cod, Ling, and Hake 125,352½ cwts. at 20s. per cwt.	125,352	10	0
Cod, Ling, and Hake 7,100 barrels in pickle at 30s. per barrel,	10,650	0	0
Total Value of Cured Fish,	£1,708,954	15	0

Fish sold fresh. White Fish.

FISH SOLD FRESH—

White Fish—

Herrings,	419,625	cwts.,	£122,034	0	0
Sprats,	67,278	,,	4,190	0	0
Mackerel,	12,369	,,	3,995	0	0
Cod,	201,108	,,	93,456	0	0
Ling,	49,090	,,	27,219	0	0
Torsk (Tusk)	531	,,	181	0	0
Saith (Coal Fish)	47,096	,,	10,406	0	0
Haddocks,	522,464	,,	304,612	0	0
Whitings,	99,638	,,	38,551	0	0
Turbot,	7,350	,,	13,535	0	0
Halibut,	28,427	,,	20,053	0	0
Sole (Lemon Sole)	5,898	,,	7,486	0	0
Flounder, Plaice, and Brill,	83,810	,,	52,865	0	0
Skate,	106,552	,,	15,765	0	0
Other Kinds of White Fish,	74,223	,,	23,476	0	0
Total Produce and Value of White Fish sold Fresh,	1,725,459	cwts.,	£737,824	0	0

Shell Fish.

Shell Fish—

	£	s.	d.
Oysters,	£809	0	0
Mussels,	15,367	0	0
Lobsters,	35,081	0	0
Crabs,	23,740	0	0
Other Kinds of Shell Fish,	14,196	0	0

	£	s.	d.	£	s.	d.
Total Value of Shell Fish,	89,193	0	0			
Total Value of Fish sold Fresh,				827,017	0	0
Salmon. SALMON,				323,851	0	0
Total value of Fisheries. GROSS TOTAL estimated value of the Sea and Salmon Fisheries of Scotland for the year 1885,				£2,859,822	15	0

ECONOMIC CHANGES IN THE FISHERY INDUSTRY.

Increased attention paid to the Fishing Industry.

The Board cannot conclude this Report without referring to the increased attention which is being paid by the trade and the public to sundry questions affecting the prosperity of the fishing industry, the discussion of which cannot fail to be ultimately beneficial to this important interest. One of these is the possibility of increasing the facilities for forwarding the fish to the consumer, and improving the existing arrangements for their distribution over the country. It is of vital importance to a fisherman to get his fish ashore fresh, and sent on to market with as little delay and at as small an expense as possible. One great advantage which the steam trawler has over the line fisherman is the facility with which he can steam to harbour with his cargo of fish; and recently steam trawlers have been taking out licences for towing purposes so that they can tow fishing boats. There is here room for an obvious improvement on the present system, for where there is any considerable fleet of boats, they might amongst them furnish sufficient employment for a small steam tender of their own, which, acting as a carrier, would enable them to devote to fishing the time now spent in running to and from the fishing grounds. As regards the mode of distribution, the practice of selling by a salesman from the boats as they arrive is, in the larger towns, such as Aberdeen, growing in favour. The fish so sold are principally bought up by middlemen in correspondence with the different markets, and who forward them by express trains all over the country. The competition is too keen to admit of the middleman taking too much profit, and practically he is no great burden on the consumer. The heaviest charge which the consumer has to pay is to the railways, the cost of the carriage of the less valuable fish being about one-third of their value. By many persons this system of selling herring by auction at the pier-head is strongly recommended in place of the 'bounty' system, adverted to in the beginning of this Report, and to which the heavy losses sustained by the curers are generally attributed. The bounty system has certainly been injurious in many ways. It has tempted the fishermen to begin fishing too early in the season, and to use nets with too small a mesh, and with the result that the fish caught are inferior in size and quality. The Board have been urged to interfere by prohibiting undersized nets; but as any rules which they might issue are only operative within the three mile limit, the matter ought soon to cure itself if the trade would adopt the practice of buying from day to day, at the prices of the day, and according to the quality of the fish. The Board have thought it best to come to no decision on the matter, till at least the result of the fishing of 1886 is seen. There is a very general desire not to purchase herrings for curing upon the East Coast and in Orkney before the 20th July, nor in Shetland before the 25th June, and at all the principal stations to buy only daily at the current prices of the day, as these may be regulated by the quality of the fish; but how far this new system will become general, and how long it will continue, remains to be seen.

Importance of Fish being sent quickly and cheaply to Market.

Mode of Distribution.

Bounty System.

We regret that, from various causes, this Report has not been transmitted to your Lordship in time to be laid before Parliament, prior to the discussion concerning the Board and its operations which took place in the House of Commons on Monday 24th May 1886.

We have the honour to be
My Lord,
Your Lordship's most obedient Servants,

THOMAS J. BOYD, *Chairman.*
JOHN GUTHRIE SMITH, *Deputy-Chairman.*
GEO. H. M. THOMS.
ALEXR. FORBES IRVINE.
J. R. G. MAITLAND.
S. WILLIAMSON.
J. COSSAR EWART.
J. MAXTONE GRAHAM.
JAS. J. GRIEVE.

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HERRING FISHERY.—ACCOUNT of the Number of Vessels fitted out in SCOTLAND for the HERRING FISHERY in the Year 1885; the Districts from which fitted out; the Tonnage and Number of Men; the Netting, Salt, and Barrels Shipped; and the Barrels of White Herrings Cured on Board.

DISTRICTS.	Vessels.	Tonnage.	Men.	Netting.	Salt.	Barrels.	Herrings Cured on Board.				Total Cured on Board of Vessels.
							Gutted.		Ungutted.		
							Gutted and Packed within 24 hours after being caught.	Gutted and Packed; but *not* within 24 hours after being caught.	Barrels.	Barrels of Bulk.	
	Number.	*Tons.*	*Number.*	*Sq. Yards.*	*Bushels.*	*Number.*	*Barrels.*	*Barrels.*	*Number.*	*Number.*	*Barrels.*
Leith, . . .	3	228	38	133,500	2,025	1,378	662	...	170	...	832
Aberdeen, . . .	1	79	12	41,000	360	286	...	...	...	...	...
Peterhead, . . .	4	268	45	234,000	5,920	2,611	2,389	222	...	41	2,652
Shetland Isles, . .	3	248	33	127,500	1,500	750	343	...	...	...	343
Stornoway, . . .	7	304	32	9,600	4,560	2,338	652	...	...	7	659
Loch Broom, . .	10	540	87	...	5,113	80	387	638	374	3,724	5,123
Loch Carron and Skye, .	32	796	98	177,000	12,174	5,662	2,087	...	140	395	2,622
Fort William, . .	17	346	65	68,100	1,586	938	750	27	...	...	777
Inveraray, . . .	7	$330\frac{1}{2}$	57	...	...	...	915	...	...	10,214	11,129
Rothesay, . . .	6	83	17	1,200	1,045	554	436	...	52	15	503
Greenock, . . .	4	92	14	...	1,530	735	6,596	...	...	1,297	7,893
Total, . .	94	$3,314\frac{1}{2}$	498	791,900	35,813	15,332	15,217	887	736	15,693	32,533

Note.—The above 94 Fishing Vessels made 113 Voyages.

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX A.—TABLE II.

HERRING FISHERY.—ACCOUNT of the Number of Barrels of WHITE HERRINGS Cured or Salted in SCOTLAND by Fish-Curers on Shore in the Year 1885; and the Districts in which Cured, distinguishing the Herrings Cured Gutted from those cured Ungutted.

DISTRICTS.	Herrings Cured Gutted.		Herrings Cured Ungutted.		Total Cured on Shore.
	Gutted and Packed within 24 hours after being caught.	Gutted and Packed; but *not* within 24 hours after being caught.	Barrels.	Barrels of Bulk.	
	Barrels.	*Barrels.*	*Number.*	*Number.*	*Barrels.*
Eyemouth, . .	17,698	1,422	3,709	10,558	33,387
Leith, . .	1,250	...	93	3,078½	4,421½
Anstruther, . .	2,707	165	715	5,435	9,022
Montrose, . .	18,926	2,883	874	2,093	24,776
Stonehaven, .	19,148	1,454	315	3,208	24,125
Aberdeen, . .	62,647	8,509	2,399	8,260	81,815
Peterhead, . .	209,157	7,939	1,249	3,090	221,435
Fraserburgh, .	262,079	3,679	101	10,460	276,319
Banff, . .	26,078	122	30	...	26,230
Buckie, . .	20,854	610	270	3,441	25,175
Findhorn, . .	7,500	178	...	9	7,687
Cromarty, . .	4,436	240	...	...	4,676
Helmsdale, . .	14,900	70	...	1,069	16,039
Lybster, . .	18,208	200	...	691	19,099
Wick, . .	108,636	2,426	399	6,293	117,754
Orkney Isles, .	49,989	3,311	...	...	53,300
Shetland Isles, .	362,141	1,081	473	6,200	369,895
Stornoway, . .	85,775	23	½	28,267¼	114,065¾
Loch Broom, .	2,964	...	...	...	2,964
Loch Carron & Skye,	4,729	...	2,469	548	7,746
Fort William, .	1,277	14	80	...	1,371
Campbeltown, .	250	...	...	44,541	44,791
Inveraray, . .	459	...	...	14,791	15,250
Rothesay, . .	211	...	965	1,786	2,962
Greenock, . .	...	...	...	8,443	8,443
Ballantrae, . .	...	...	628	27,043	27,671
Total, . .	1,302,019	34,326	14,769½	189,304¾	1,540,419¼

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM,
Secretary.

APPENDIX A.—TABLE III.

HERRING FISHERY.—ACCOUNT of the Total Number of Barrels of WHITE HERRINGS Cured or Salted in SCOTLAND, on Board of Vessels and on Shore, in the Year 1885; distinguishing the Herrings Cured Gutted from those Cured Ungutted.

DISTRICTS.	Herrings Cured Gutted.		Herrings Cured Ungutted.		Total Herrings Cured on board of Vessels and on Shore.
	Gutted and Packed within 24 hours after being caught.	Gutted and Packed; but *not* within 24 hours after being caught.	Barrels.	Barrels of Bulk.	
	Barrels.	*Barrels.*	*Number.*	*Number.*	*Barrels.*
Eyemouth,	17,698	1,422	3,709	10,558	33,387
Leith,	1,912	...	263	3,078½	5,253½
Anstruther,	2,707	165	715	5,435	9,022
Montrose,	18,926	2,883	874	2,093	24,776
Stonehaven,	19,148	1,454	315	3,208	24,125
Aberdeen,	62,647	8,509	2,399	8,260	81,815
Peterhead,	211,546	8,161	1,249	3,131	224,087
Fraserburgh,	262,079	3,679	101	10,460	276,319
Banff,	26,078	122	30	...	26,230
Buckie,	20,854	610	270	3,441	25,175
Findhorn,	7,500	178	...	9	7,687
Cromarty,	4,436	240	...	...	4,676
Helmsdale,	14,900	70	...	1,069	16,039
Lybster,	18,208	200	...	691	19,099
Wick,	108,636	2,426	399	6,293	117,754
Orkney Isles,	49,989	3,311	...	...	53,300
Shetland Isles,	362,484	1,081	473	6,200	370,238
Stornoway,	86,427	23	½	28,274¼	114,724¾
Loch Broom,	3,351	638	374	3,724	8,087
Loch Carron & Skye,	6,816	...	2,609	943	10,368
Fort William,	2,027	41	80	...	2,148
Campbeltown,	250	...	...	44,541	44,791
Inveraray,	1,374	...	...	25,005	26,379
Rothesay,	647	...	1,017	1,801	3,465
Greenock,	6,596	...	...	9,740	16,336
Ballantrae,	...	...	628	27,043	27,671
Total,	1,317,236	35,213	15,505½	204,997¾	1,572,952¼

SUPPLEMENTARY NOTE, showing the Number of Barrels of WHITE HERRINGS Cured or Salted on the West Coast of Scotland in the Year 1885, stated according to the Districts where the Herrings were caught.

DISTRICTS.	Barrels.
Stornoway,	114,781¾
Loch Broom,	8,948
Loch Carron and Skye,	15,950
Fort William,	2,412
Campbeltown,	45,342
Inveraray,	26,379
Rothesay,	3,673
Greenock,	8,813
Ballantrae,	27,671
Total,	253,969¾

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX A.—TABLE IV.

HERRING FISHERY.—ACCOUNT of the Total Number of Barrels of WHITE HERRINGS Branded in SCOTLAND in the Year 1885; and of the Brandings in each District.

DISTRICTS.	Total Branded.
Eyemouth, ...	2,111½
Leith, ...	263
Anstruther, ...	820
Montrose, ...	13,280½
Stonehaven, ...	13,146½
Aberdeen, ...	47,648
Peterhead, ...	153,000
Fraserburgh, ...	148,464½
Banff, ...	20,162
Buckie, ...	14,777
Findhorn, ...	5,863½
Cromarty, ...	3,349½
Helmsdale, ...	11,653½
Lybster, ...	11,621½
Wick, ...	67,484
Orkney Isles, ...	30,799½
Shetland Isles, ...	144,880½
Total, . . .	*689,325

* Of this number,	220,491½	Barrels	were branded	Crown	FULL.
,,	313,258	,,	were branded	,,	MATIES.
,,	86,744½	,,	were branded	,,	SPENT.
,,	68,831	,,	were branded	,,	MIXED.
,,	...	,,	were branded	,,	REPACKED.

689,325 Barrels. The Fees thereon amounted to £11,488 15 0

Bank Interest, . . . 4

Total Receipts, £11,488 15 4

NOTE, showing the Total Number of Barrels in the foregoing Account Branded 'Full,' 'Maties,' or 'Spent.'

DISTRICTS.	Number of Barrels assorted and Branded.		
	Crown *Full.*	*Maties.*	*Spent.*
Eyemouth, ...	1,083½	501	374
Leith, ...	63	121	21
Anstruther, ...	41	253	72
Montrose, ...	3,150	5,864	3,527½
Stonehaven, ...	4,390½	5,617	2,140½
Aberdeen, ...	13,830½	21,648½	6,963
Peterhead, ...	45,164½	81,880	20,040
Fraserburgh, ...	40,645	83,673	10,524
Banff, ...	4,085½	10,703½	2,833½
Buckie, ...	4,048	4,953½	2,023
Findhorn, ...	2,463½	2,734	267
Cromarty, ...	1,735½	1,240	374
Helmsdale, ...	6,347½	4,171	1,076
Lybster, ...	5,578	3,005½	53
Wick, ...	26,934	31,666	5,125
Orkney Isles, ...	10,302	15,765	1,383½
Shetland Isles, ...	50,629½	39,462	29,947½
Total, ...	220,491½	313,258	86,744½

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX A.—TABLE V.

HERRING FISHERY.—ACCOUNT of the Number of Barrels of WHITE HERRINGS Exported from SCOTLAND in the Year 1885; distinguishing the Export to Ireland, to the Continent, and to places out of Europe; distinguishing also Herrings Cured Gutted from Herrings Cured Ungutted; and Herrings Bung-Packed from Herrings Repacked.

DISTRICTS.	BARRELS OF HERRINGS EXPORTED.							
	To Ireland.			To the Continent.		To Places out of Europe.		Total Exported.
	Bung-Packed.		Barrels of Bulk.	Bung-Packed.		Bung-Packed.	Repacked.	
	Gutted.	Ungutted.		Gutted.	Ungutted.	Gutted.	Gutted.	
	Barrels.	*Barrels.*	*Number.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
Eyemouth,	2,004	57	...	5,501	...	...	...	7,562
Leith,	...	...	...	44,369	...	...	...	44,369
Anstruther,	...	...	...	1,521	...	...	...	1,521
Montrose,	...	...	...	17,633½	...	...	...	17,633½
Stonehaven,	...	...	...	12,232½	...	...	...	12,232½
Aberdeen,	...	...	...	65,236½	...	205	263	65,704½
Peterhead,	...	...	...	185,120	103	...	...	185,223
Fraserburgh,	...	...	...	208,114	...	...	..	208,114
Banff,	...	...	...	20,677	...	...	...	20,677
Buckie,	...	...	...	15,165	...	...	...	15,165
Findhorn,	...	...	...	5,793	...	...	...	5,793
Cromarty,	...	...	...	3,733½	...	...	...	3,733½
Helmsdale,	...	...	...	1,3221½	...	...	...	13,221½
Lybster,	1,112½	...	...	15,086½	...	...	...	16,199
Wick,	5,168½	...	...	86,464½	...	...	...	91,633
Orkney Isles,	7,034	...	...	40,295	...	...	...	47,329
Shetland Isles,	748	...	...	305,925	...	...	...	306,673
Stornoway,	...	...	...	58,514	...	...	...	58,514
Loch Carron and Skye	430	140	275	...	...	...	...	845
Greenock	5,039	100	603	...	...	186	519	6,447
Total,	21,536	297	878	1,104,602½	103	391	782	1,128,589½

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

SUPPLEMENTARY NOTE, showing the Ports or Places to which the Herrings Exported to the Continent were Shipped.

STATIONS.	BARRELS OF HERRINGS EXPORTED.															Total Exported to the Continent.
	Russia.				Germany.								Holland.		Other Places on the Continent.	
	Odessa.	Peters-burg.	Riga.	Libau.	Revel.	Memel.	Königs-berg.	Elbing.	Danzig.	Stettin.	Ham-burg.	Bremen.	Rotter-dam.	Amster-dam.		
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
Eyemouth,	...	...	...	...	...	...	623	...	...	1,513⅓	3,364½	...	...	...	...	5,501
Leith,	...	955	...	...	...	...	1,828⅓	...	...	12,719	28,186	115	533½	10	22	44,369
Anstruther,	...	...	...	...	...	...	...	...	1,113	408	...	...	...	...	...	1,521
Montrose,	...	...	...	...	...	...	...	...	11,188	6,445½	...	...	...	...	...	17,633½
Stonehaven,	...	...	...	1,024½	...	...	3,779⅓	...	6,913½	...	515	...	...	...	...	12,232½
Aberdeen,	645	...	...	2,522½	...	...	18,595½	...	17,069	20,798	5,559½	...	...	...	47	65,236½
Peterhead,	...	...	5,194	46,032½	...	3,449	27,759½	...	24,472½	47,055	31,260½	...	...	...	...	185,223
Fraserburgh,	...	...	9,558½	26,525½	1,000	4,155	46,320½	1,314	34,224	55,958	28,033½	1,025	...	...	...	208,114
Banff,	...	...	...	...	...	...	2,154	...	7,486	11,037	...	...	...	...	...	20,677
Buckie,	...	...	...	2,880	...	...	2,601½	...	4,562	5,121½	...	...	...	...	...	15,165
Findhorn,	...	...	...	...	...	...	...	...	1,429½	4,363½	...	...	...	...	...	5,793
Cromarty,	...	...	...	...	...	...	...	...	365½	3,065	303	...	...	...	...	3,733½
Helmsdale,	...	...	...	1,983	...	703	...	...	585	5,634½	4,316	...	...	...	...	13,221½
Lybster,	...	...	...	...	...	...	843	...	5,093	5,708	2,913⅓	529	...	...	...	15,086½
Wick,	...	...	1,866	...	...	2,434	11,539	...	21,777½	33,004½	15,518½	...	...	...	325	86,464½
Orkney Isles,	...	...	651	...	...	...	2,163	...	8,919½	27,408½	1,153	...	...	...	...	40,295
Shetland Isles,	...	...	7,886	6,261	...	1,002	48,290½	...	37,969½	161,525½	42,990½	...	...	...	...	305,925
Stornoway,	...	43,899½	1,484	...	...	...	1,129	...	...	9,557¾	2,443¾	...	...	...	...	58,514
Total,	645	44,854½	26,639½	87,229	1,000	11,743	167,626⅓	1,314	183,167½	411,322¾	166,557¼	1,669	533½	10	394	1,104,705½

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX A.—TABLE VI.

HERRING FISHERY.—ABSTRACT showing the Total Quantity of WHITE HERRINGS Cured, Branded, and Exported, year by year, *in so far as brought under cognizance of Fishery Officers*, from the 1st of June 1809 to the 31st of December 1885; distinguishing the Export to Ireland, to the Continent, and to places out of Europe.

PERIODS.	Total Quantity of Herrings Cured.			Total Quantity of Herrings Branded.	Total Quantity of Herrings Exported.			Grand Total Exported.
	Gutted.	Ungutted including Bulk.	Total Cured.		To Ireland.	To the Continent.	To places out of Europe.	
	Barrels.	*Bls. or Crans.*	*Barrels.*	*Barrels.*	*Bls. or Crans.*	*Barrels.*	*Barrels.*	*Barrels.*
Period extending from 1st June 1809 to 5th April 1810,	42,548	47,637½	90,185½	34,701	28,014	...	7,834	35,848
Year ended 5th April 1811,	65,430	26,397½	91,827½	55,662½	28,212	...	9,921	38,133
Year ended 5th April 1812,	72,515½	39,004	111,519½	58,430	30,417½	4,730	27,672½	62,820
Year ended 5th April 1813,	89,900¾	63,587½	153,488¼	70,027½	57,980	11,046½	40,699	109,725½
Year ended 5th April 1814,	52,931½	57,611	110,542½	38,184½	43,061½	23,943	51,399	118,403½
Year ended 5th April 1815,	105,372¼	54,767	160,139¼	83,376	49,635¾	35,891	55,778½	141,305¼
Year ended 5th April 1816,	135,981	26,670¾	162,651¾	116,436	29,456½	15,563	62,668½	107,688
Year ended 5th April 1817,	155,776	36,567½	192,343½	140,018½	36,341	44,432½	57,855	138,628½
Year ended 5th April 1818,	204,270¼	23,420¾	227,691	183,089½	53,386½	43,896	65,057	162,339½
Year ended 5th April 1819,	303,777½	37,116½	340,894	270,022½	89,704	52,333	85,125	227,162
Year ended 5th April 1820,	347,190½	35,301	382,491½	309,700½	101,109½	64,302½	88,104	253,516
Year ended 5th April 1821,	413,308	28,887¾	442,195¾	363,872	125,445	89,524	79,836½	294,805½
Year ended 5th April 1822,	291,626½	24,897¾	316,524¼	263,205½	102,719	34,752	77,485	214,956
Year ended 5th April 1823,	225,037	23,832	248,869	203 110	56,528	38,002½	75,914½	170,445
Year ended 5th April 1824,	335,450	56,740¾	392,190¾	299,631	116,747½	40,231	82,652	239,630½

APPENDIX A.—TABLE VI.—*Continued.*

PERIODS.	Total Quantity of Herrings Cured.			Total Quantity of Herrings Branded.	Total Quantity of Herrings Exported.			Grand Total Exported.
	Gutted.	Ungutted including Bulk.	Total Cured.		To Ireland.	To the Continent.	To places out of Europe.	
	Barrels.	*Bls. or Crans.*	*Barrels.*	*Barrels.*	*Bls. or Crans.*	*Barrels.*	*Barrels.*	*Barrels.*
Year ended 5th April 1825, . . .	303,397	44,268¼	347,665¼	270,844½	96,409½	35,029½	70,577½	202,016½
Year ended 5th April 1826, . . .	340,118	39,115¾	379,233¾	294,422½	121,386½	28,167¾	67,519	217,073¼
Year ended 5th April 1827, . . .	259,171¼	29,324	288,495¼	223,606	78,735	16,701	70,970	166,406
Year ended 5th April 1828, . . .	339,360	60,418	399,778	279,317½	109,108½	24,489½	78,061	211,659
Year ended 5th April 1829, . . .	300,242½	55,737	355,979½	234,827	107,651	28,280½	69,944	205,875½
Year ended 5th April 1830, . . .	280,933½	48,623½	329,557	218,418½	89,680½	24,302	67,672	181,654½
Year ended 5th April 1831, . . .	371,096	68,274¼	439,370¼	237,085	130,300½	61,655½	72,947	264,903
Year ended 5th April 1832, . . .	313,113¾	49,547	362,660¾	157,839½	128,458	31,100¼	57,941½	217,499¾
Year ended 5th April 1833, . . .	353,684½	63,279¾	416,964¼	168,259½	114,137	47,556½	58,991	220,684½
Year ended 5th April 1834, . . .	382,677½	68,853¾	451,531¼	178,000½	149,254	55,852	66,987½	272,093½
Year ended 5th April 1835, . . .	217,242½	60,074½	277,317	85,079½	73,960	34,050	50,795½	158,805½
Year ended 5th April 1836, . . .	399,334	98,280¾	497,614¾	192,317	168,960	48,451½	55,982	273,393½
Year ended 5th April 1837, . .	290,169	107,660¼	397,829¼	114,192	102,968½	46,777	39,520	189,265½
Year ended 5th April 1838, . . .	382,400	125,374¾	507,774¾	141,552	139,095	57,388½	38,674½	235,158
Year ended 5th April 1839, . . .	382,229	173,330¾	555,559¾	153,659½	149,926	64,870	24,934½	239,730½
Year ended 5th April 1840, . . .	405,379½	138,565½	543,945	152,231	157,359	82,515½	12,647½	252,522
Year ended 5th April 1841, . . .	431,157	126,105¼	557,262¼	154,189	150,517½	90,951½	8,668	250,137
Year ended 5th April 1842, . .	489,620½	177,624¾	667,245¼	190,922½	187,953	91,069½	5,713½	284,736

APPENDIX A.—TABLE VI.—*Continued.*

PERIODS.	Total Quantity of Herrings Cured.			Total Quantity of Herrings Branded.	Total Quantity of Herrings Exported.			Grand Total Exported.
	Gutted.	Ungutted including Bulk.	Total Cured.		To Ireland.	To the Continent.	To places out of Europe.	
	Barrels.	*Bls. or Crans.*	*Barrels.*	*Barrels.*	*Bls. or Crans.*	*Barrels.*	*Barrels.*	*Barrels.*
Year ended 5th April 1843,	442,290	181,129¾	623,419¾	162,713	165,327½	120,136½	6,336½	291,800½
Year ended 5th April 1844,	473,556¾	191,803	665,359¾	182,988	127,770	181,953	3,793½	313,516½
Period extending from 5th April 1844 to 5th January 1845,	393,312	132,720¾	526,032¾	140,632	120,293	143,754	2,326½	266,373½
Year ended 5th January 1846,	411,271	121,375	532,646	142,473½	127,027½	113,678	2,488½	243,194
Year ended 5th January 1847,	414,915¼	192,535¾	607,451	156,278½	102,585	148,363½	4,765½	255,714
Year ended 5th January 1848,	372,989½	189,754	562,743½	146,500½	102,690	142,532	4,959	250,181
Year ended 5th January 1849,	392,827	251,541¼	644,368¼	153,944	78,262½	168,049	3,682½	249,994
Year ended 5th January 1850,	507,024½	263,673¾	770,698¼	213,286½	78,889¾	257,108	4,258½	340,256¼
*Year ended 5th January 1851, for Scotland and the Isle of Man only,	378,187	165,822½	544,009½	172,924½	66,138	198,403	2,367	266,908
Year ended 5th January 1852, for do. do.	417,233¼	176,797¾	594,031	201,636½	81,340½	182,659	205	264,204½
Year ended 31st December 1852, for do. do.	375,693	123,094½	498,787½	169,159½	60,414	221,979	1,133	283,526
Year ended 31st December 1853, for do. do.	560,367	217,672¾	778,039¾	248,136½	95,339	242,853¼	4,438½	342,630¾
Year ended 31st December 1854, for do. do.	458,579½	177,982¾	636,562¼	211,844	121,883¾	237,893½	1,919½	361,696¾
Year ended 31st December 1855, for do. do.	582,715¼	183,988¼	766,703½	280,581½	97,377	344,029	858	442,264
Year ended 31st December 1856, for do. do.	466,429½	143,559	609,988½	223,281	89,670¾	256,741	1,199½	347,611¼
Year ended 31st December 1857, for do. do.	465,292½	115,521¼	580,813¾	218,992	58,534	307,275½	1,351	367,160½

*The Collection of Returns for England ceased from the 5th of January 1850, and for the Isle of Man from the 1st of January 1869.

APPENDIX A.—TABLE VI.—*Continued.*

PERIODS.	Total Quantity of Herrings Cured.			Total Quantity of Herrings Branded.	Total Quantity of Herrings Exported.			Grand Total Exported.
	Gutted.	Ungutted including Bulk.	Total Cured.		To Ireland.	To the Continent.	To places out of Europe.	
	Barrels.	*Bls. or Crans.*	*Barrels.*	*Barrels.*	*Bls. or Crans.*	*Barrels.*	*Barrels.*	*Barrels.*
Year ended 31st December 1858, for Scotland and the Isle of Man only, . . .	470,393¼	165,730¼	636,124	233,374	79,054	269,819	1,331½	350,204½
*Year ended 31st December 1859, for do. do. .	381,059¼	110,428	491,487¼	158,676	68,882	203,349½	748	272,979½
Year ended 31st December 1860, for do. do. .	496,414½	184,778¾	681,193¼	231,913½	86,413	291,401½	156	377,970½
Year ended 31st December 1861, for do. do. .	519,173	149,655½	668,828½	265,347	81,595½	308,334¼	384	390,313¾
Year ended 31st December 1862, for do. do. .	656,048	174,856	830,904	346,712	70,879¾	423,182¾	847½	494,910
Year ended 31st December 1863, for do. do. .	507,223	147,593½	654,816½	276,880½	72,074½	333,074¼	2,612¾	407,761½
Year ended 31st December 1864, for do. do. .	478,781½	164,868¾	643,650¼	217,392	55,420½	307,282	1,805	364,507½
Year ended 31st December 1865, for do. do. .	470,559½	151,203½	621,763	216,785	42,063	309,626	1,012	352,701
Year ended 31st December 1866, for do. do. .	497,814½	160,332¼	658,146¾	249,510	47,319	328,272½	4,474½	380,066
Year ended 31st December 1867, for do. do. .	631,759½	193,829½	825,589	317,421	42,364¼	432,994½	3,345½	478,704¼
Year ended 31st December 1868, for do. do. .	445,468½	205,965¼	651,433¾	209,462½	43,414½	323,479¾	1,850½	368,744¾
†Year ended 31st December 1869, for Scotland only	488,831	186,312	675,143	244,522½	32,342½	346,793¾	2,197½	381,333¾
Year ended 31st December 1870, for do. .	657,059½	176,101	833,160½	299,381½	41,524	486,064	2,970	530,558
Year ended 31st December 1871, for do. .	668,489½	156,986¼	825,475¾	346,633½	46,347	502,534¼	2,724	551,605¼
Year ended 31st December 1872, for do. .	671,703½	102,156	773,859½	422,731½	24,147	523,540½	1,943½	549,631
Year ended 31st December 1873, for do. .	796,902	142,331½	939,233½	435,274½	32,465½	633,681	1,861½	668,008
Year ended 31st December 1874, for do. .	887,002½	113,558½	1,000,561	517,558½	28,137¼	706,967¾	2,209¾	737,314¾

* By Act 21st and 22nd Vict. cap. 69 (1858), there was imposed upon the Branding of Barrels and Half-Barrels of Herrings a Fee of *Fourpence* per Barrel and *Twopence* per Half-Barrel.
† The Collection of Returns for England ceased from the 5th of January 1850, and for the Isle of Man from the 1st of January 1869.

APPENDIX A.—TABLE VI.—*Continued.*

PERIODS.	Total Quantity of Herrings Cured.			Total Quantity of Herrings Branded.	Total Quantity of Herrings Exported.			Grand Total Exported.
	Gutted.	Ungutted including Bulk.	Total Cured.		To Ireland.	To the Continent.	To places out of Europe.	
	Barrels.	*Bls. or Crans.*	*Barrels.*	*Barrels.*	*Bls. or Crans.*	*Barrels.*	*Barrels.*	*Barrels.*
Year ended 31st December 1875, for Scotland only,	834,822½	108,157½	942,980	523,789½	33,434	624,137½	3,399	660,970½
Year ended 31st December 1876, for do.	486,238½	111,959	598,197½	252,979½	20,333	378,740	1,350½	400,423½
Year ended 31st December 1877, for do.	716,871¼	130,847½	847,718¾	397,795	16,085½	543,908¼	1,992	561,985¾
Year ended 31st December 1878, for do.	771,556	134,212	905,768	456,708	17,445¾	608,969¼	2,519	628,934
Year ended 31st December 1879, for do.	655,991	185,805	841,796	342,323	8,857½	536,380½	755½	545,993½
Year ended 31st December 1880, for do.	1,224,198½	249,401¾	1,473,600¼	689,286	32,482½	976,300½	1,028½	1,009,811½
Year ended 31st December 1881, for do.	915,098	196,057¼	1,111,155¼	494,182½	33,459¼	711,448	972½	745,879¾
Year ended 31st December 1882, for do.	980,755½	302,218	1,282,973½	462,612½	40,377	782,576¼	3,029½	825,982¾
Year ended 31st December 1883, for do.	1,033,087	236,325½	1 269,412½	470,995½	25,870	863,644½	1,246	890,760½
Year ended 31st December 1884, for do.	1,452,213	244,864¼	1,697,077¼	653,425	35,299½	1,148,956½	964½	1,185,220½
Year ended 31st December 1885, for do.	1,352,449	220,503¼	1,572,952¼	689,325	22,711	1,104,705½	1,173	1,128,589½

N.B.—In the Six Years ended 5th April 1815, the Bounty on Herrings Cured Gutted was 2s. per Barrel, while there was a Bounty at the same time of 2s. 8d. per Barrel, payable by the Excise on the Exportation of Herrings, whether Cured Gutted or Ungutted, but which ceased on the 1st June 1815; in the Eleven Years ended 5th April 1826, the Bounty on Herrings Cured Gutted was 4s. per Barrel; in the Four succeeding Years the Bounty was reduced 1s. per Barrel each Year till the 5th of April 1830, when it ceased altogether.

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX B.—TABLE I.

COD AND LING FISHERY.—ACCOUNT, by Districts, of the Number of Vessels fitted out in SCOTLAND for the COD and LING Fishery, in the Year 1885; of the Tonnage of the Vessels, and the Number of Men; also of the Quantity of COD, LING and HAKE Cured on Board; distinguishing whether Cured Dried or Cured in Pickle.

DISTRICTS.	Vessels.	Tonnage.	Men.	Total Quantity of Cod, Ling and Hake Cured on board of Vessels.	
				Number of Fish.	Cured Dried.
	Number.	*Tons.*	*Number.*	*Number.*	*Cwts.*
Leith, . . .	3	228	35	...	...
Fraserburgh, . .	9	165	54	28,870	1,040
Orkney Isles, . .	22	1,398	237	155,390	4,593
Shetland Isles, .	24	1,311	264	432,132	8,832
Stornoway, . .	1	55	9	117	4
Total, . .	59	3,157	599	616,509	14,469

Fishery Board for Scotland, Edinburgh, 1st May 1886. DUGALD GRAHAM, *Secretary.*

APPENDIX B.—TABLE II.

COD AND LING FISHERY.—ACCOUNT, by Districts, of the COD, LING and HAKE taken at the Cod and Ling Fishery in SCOTLAND by Open Boats and Cured on Shore, in the Year 1885; distinguishing the Fish Cured Dried and the Fish Cured in Pickle.

DISTRICTS.	Total Quantity of Cod, Ling and Hake Cured on Shore.		
	Number of Fish.	Cured Dried.	Cured in Pickle.
	Number.	*Cwts.*	*Barrels.*
Anstruther, ...	172,769	7,260	89
Montrose, ...	66,185	2,275	...
Stonehaven, ...	15,826	572½	...
Aberdeen, ...	43,218	1,486½	5
Peterhead, ...	30,862	744	285
Fraserburgh, ...	99,152	3,240	215
Banff, ...	55,425	1,900	314
Buckie, ...	80,919	1,003	2,981
Findhorn, ...	24,592	207	768
Cromarty, ...	1,052	6	35
Helmsdale, ...	3,355	55	77
Lybster, ...	11,460	68	399
Wick, ...	61,928	844	1,802
Orkney Isles, ...	423,103	13,695	43
Shetland Isles, ...	1,094,676	49,759	...
Stornoway, ...	420,609	18,213	62
Loch Broom, ...	79,375	3,200	...
Loch Carron and Skye, ...	45,648	1,805	...
Fort William, ...	85,620	3,365	...
Campbeltown, ...	36,992	1,185½	25
Total, . .	2,852,766	110,883½	7,100

Fishery Board for Scotland, Edinburgh, 1st May 1886. DUGALD GRAHAM, *Secretary.*

APPENDIX B.—TABLE III.

COD AND LING FISHERY.—ACCOUNT, by Districts, of the Total Quantity of COD, LING and HAKE taken, both by Vessels and by Open Boats, at the Cod and Ling Fishery in SCOTLAND, and Cured, in the Year 1885; distinguishing the Fish Cured Dried and the Fish Cured in Pickle.

DISTRICTS.	Total Quantity of Cod, Ling and Hake Cured.		
	Number of Fish.	Cured Dried.	Cured in Pickle.
	Number.	*Cwts.*	*Barrels.*
Anstruther,	172,769	7,260	89
Montrose,	66,185	2,275	...
Stonehaven,	15,826	572½	...
Aberdeen,	43,218	1,486½	5
Peterhead,	30,862	744	285
Fraserburgh,	120,022	4,280	215
Banff,	55,425	1,900	314
Buckie,	80,919	1,003	2,981
Findhorn,	24,592	207	768
Cromarty,	1,052	6	35
Helmsdale,	3,355	55	77
Lybster,	11,460	68	399
Wick,	61,928	844	1,802
Orkney Isles,	578,493	18,288	43
Shetland Isles,	1,526,808	58,591	...
Stornoway,	420,726	18,217	62
Loch Broom,	79,375	3,200	...
Loch Carron and Skye,	45,648	1,805	...
Fort William,	85,620	3,365	...
Campbeltown,	36,992	1,185½	25
Total,	3,461,275	125,352½	7,100

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX B.—TABLE IV.

COD AND LING FISHERY.—ACCOUNT of the Total Quantity of COD, LING and HAKE Exported from SCOTLAND, in the Year 1885; with the Districts from which Exported; distinguishing the Export to Ireland, to the Continent, and to places out of Europe; also whether Cured Dried or Cured in Pickle.

DISTRICTS.	Cod, Ling and Hake Exported.					
	To Ireland.	To the Continent.		To Places out of Europe.	Total Exported.	
	Cured Dried.	Cured Dried.	Cured in Pickle.	Cured Dried.	Cured Dried.	Cured in Pickle.
	Cwts.	*Cwts.*	*Barrels.*	*Cwts.*	*Cwts.*	*Barrels.*
Leith,	9,395	2,972	...	4,157	16,524	...
Aberdeen,	...	...	...	3,753	3,753	...
Orkney Isles,	1,581	...	...	737	2,318	...
Shetland Isles,	14,124	3,717	...	...	17,841	...
Campbeltown,	864	...	...	...	864	...
Greenock,	4,180	...	...	1,761	5,941	...
Total,	30,144	6,689	...	10,408	47,241	...

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX B.—TABLE V.

COD AND LING FISHERY.—ABSTRACT, showing the Total Quantity of COD, LING, and HAKE Cured, Punched, or Branded, and Exported, year by year, *in so far as brought under cognizance of Fishery Officers*, from the 10th of October 1820, when the System for Encouragement and Improvement of the Cod and Ling Fishery commenced, to the 31st of December 1885.

PERIODS.	Total Quantity of Cod, Ling and Hake Cured.			Total Quantity of Cod Ling and Hake Punched or Branded.		Total Quantity of Cod, Ling and Hake Exported.			
	Cured Dried.	Cured in Pickle.		Cured Dried.	Cured in Pickle.	Cured Dried.			Cured in Pickle.
	Cwts.	*Cwts.*	*Barrels.*	*Cwts.*	*Barrels.*	*Cwts.*	*qrs.*	*lbs.*	*Barrels.*
Period extending from 10th Oct. 1820 to 5th April 1822,	...	...	...	50,235¼	4,919½	19,578	3	,,	...
Year ended 5th April 1823,	...	...	...	54,573	3,691	19,398	3	,,	...
Year ended 5th April 1824,	...	...	...	63,590	5,437	23,098	,,	3	..
Year ended 5th April 1825,	..	...	...	52,135	3,531	14,087	2	19	...
Year ended 5th April 1826,	69,136½	3,634¾	5,621	66,315¾	5,337	7,281	1	14	...
Year ended 5th April 1827,	95,161½	9,273	9,025	82,185¾	8,008½	14,051	2	27	...
Year ended 5th April 1828,	82,515¼	6,726	6,142½	74,103¾	5,609½	13,208	2	,,	...
Year ended 5th April 1829,	81,321¼	5,786	6,819	73,500½	6,204	20,587	3	4	...
Year ended 5th April 1830,	101,914	5,652½	8,836½	92,314½	8,464	16,369	3	15	...
Year ended 5th April 1831,	37,674	...	2,950½	31,337½	2,459½	11,920	1	1	...
Year ended 5th April 1832,	50,293	...	3,779½	13,879¾	3,230	20,168	3	16	47
Year ended 5th April 1833,	58,461½	...	6,467½	13,581¼	4,393½	14,754	1	26	67
Year ended 5th April 1834,	52,710½	...	5,522½	14,255½	3,829	16,298	3	,,	24
Year ended 5th April 1835,	44,152¾	...	3,767½	9,492¼	2,235	10,632	2	24	..
Year ended 5th April 1836,	38,040	...	6,276	6,766	3,018	10,992	2	20	...

APPENDIX B.—TABLE V.—*Continued.*

PERIODS.	Total Quantity of Cod, Ling and Hake Cured.			Total Quantity of Cod, Ling and Hake Punched or Branded.		Total Quantity of Cod, Ling and Hake Exported.			
	Cured Dried.	Cured in Pickle.		Cured Dried.	Cured in Pickle.	Cured Dried.			Cured in Pickle.
	Cwts.	*Cwts.*	*Barrels.*	*Cwts.*	*Barrels.*	*Cwts.*	*qrs.*	*lbs.*	*Barrels.*
Year ended 5th April 1837,	66,892½	...	7,273	9,589½	3,206	10,195	2	11	1½
Year ended 5th April 1838,	84,996¾	...	10,303	9,259½	4,373	22,166	2	12	36
Year ended 5th April 1839,	85,279¾	...	10,051½	23,936¼	5,093	26,701	3	,,	150
Year ended 5th April 1840,	93,560¾	..	6,053	21,695½	3,205	29,656	1	,,	24
Year ended 5th April 1841,	91,494¾	...	9,480	21,029¼	3,891	30,550	1	,,	44
Year ended 5th April 1842,	76,849	...	7,038½	13,283¾	2,164	25,293	1	,,	...
Year ended 5th April 1843,	77,207¼	...	6,431	10,030¼	1,342	23,737	3	,,	70
Year ended 5th April 1844,	92,813½	...	5,123	20,810¼	2,226½	35,476	,,	,,	4
Period extending from 5th April 1844 to 5th Jan. 1845,	83,919	...	1,726	17,940¼	229	28,815	,,	,,	20
Year ended 5th January 1846,	92,323	...	5,037	14,372½	935	29,352	,,	,,	...
Year ended 5th January 1847,	90,783¾	...	6,341½	12,387½	1,492	34,435	1	,,	15
Year ended 5th January 1848,	86,624¼	...	6,247½	8,145¼	955	25,662	3	,,	...
Year ended 5th January 1849,	85,463	...	6,810½	9,520	1,681	22,608	3	,,	...
Year ended 5th January 1850,	98,903	...	6,588	15,556	997	24,154	1	,,	20
*Year ended 5th January 1851, for Scotland and the Isle of Man only,	90 658¾	...	5,032	†...	...	22,304	1	,,	...
Year ended 5th January 1852, for do. do.	92,083¼	...	7,019¾	...	...	17,141	2	,,	...
Year ended 31st December 1852, for do. do.	102,976¼	...	6,886	...	...	18,994	2	,,	...
Year ended 31st December 1853, for do. do.	105,596	...	5,122½	...	...	22,650	3	,,	14

* The Collection of Returns for England ceased from the 5th of January 1850.

† The Punching and Branding of Cod and Ling ceased from the 5th of January 1850.

APPENDIX B.—TABLE V.—*Continued.*

PERIODS.	Total Quantity of Cod, Ling and Hake Cured.			Total Quantity of Cod, Ling and Hake Punched or Branded.		Total Quantity of Cod, Ling and Hake Exported.			
	Cured Dried.	Cured in Pickle.		Cured Dried.	Cured in Pickle.	Cured Dried.			Cured in Pickle.
	Cwts.	*Cwts.*	*Barrels.*	*Cwts.*	*Barrels.*	*Cwts.*	*qrs.*	*lbs.*	*Barrels.*
Year ended 31st December 1854, for Scotland and the Isle of Man only, ...	109,684$\frac{1}{4}$	...	6,166$\frac{1}{2}$	...	...	19,557	2	,,	...
Year ended 31st December 1855, for do. do. .	113,561$\frac{1}{4}$	...	6,316$\frac{1}{2}$	...	...	29,154	2	,,	25
Year ended 31st December 1856, for do. do. .	110,504$\frac{3}{4}$	...	6,642	...	...	29,629	3	,,	...
Year ended 31st December 1857, for do. do. .	104,668$\frac{1}{2}$	...	4,393$\frac{1}{2}$	...	...	34,310	,,	,,	...
Year ended 31st December 1858, for do. do. .	95,596	...	4,584	...		32,152	,,	,,	...
Year ended 31st December 1859, for do. do. .	118,383	...	5,362$\frac{1}{2}$	...	...	35,923	,,	,,	...
Year ended 31st December 1860, for do. do. .	115,688	...	4,339$\frac{1}{2}$	...	...	32,221	,	,,	...
Year ended 31st December 1861, for do. do. .	82,344$\frac{3}{4}$	...	4,145$\frac{1}{2}$	...	...	26,961	,,	,,	...
Year ended 31st December 1862, for do. do. .	100,657$\frac{1}{2}$	...	7,735$\frac{1}{2}$	...	...	32,969	3	,,	...
Year ended 31st December 1863, for do. do. .	129,725$\frac{3}{4}$	...	7,337	...	...	53,736	,,	,,	...
Year ended 31st December 1864, for do. do. .	107,758$\frac{1}{4}$	...	7,963$\frac{1}{2}$	...	...	46,461	,,	,,	...
Year ended 31st December 1865, for do. do. .	112,807	..	7,678	...	...	44,928	3	,,	...
Year ended 31st December 1866, for do. do. .	115,819	...	9,957$\frac{1}{2}$	...	...	47,753	,,	,,	15
Year ended 31st December 1867, for do. do. .	119,638$\frac{1}{4}$	...	10,819	...	...	46,225	,,	,,	...
Year ended 31st December 1868, for do. do. .	113,831	...	9,659	...	...	52,403	,,	,,	...
*Year ended 31st December 1869, for Scotland only, .	135,585$\frac{1}{4}$	...	10,319	...	...	51,864	2	,,	...
Year ended 31st December 1870, for do. .	145,288$\frac{3}{4}$	...	9,945	...	...	56,400	2	,,	...
Year ended 31st December 1871, for do. .	119,030	...	9,283	...	...	54,171	1	,,	...

* The Collection of Returns for the Isle of Man ceased from the 1st of January 1869.

APPENDIX B.—TABLE V.—*Continued.*

PERIODS.	Total Quantity of Cod, Ling and Hake Cured.			Total Quantity of Cod, Ling and Hake Punched or Branded.		Total Quantity of Cod, Ling and Hake Exported.			
	Cured Dried.	Cured in Pickle.		Cured Dried.	Cured in Pickle.	Cured Dried.			Cured in Pickle.
	Cwts.	*Cwts.*	*Barrels.*	*Cwts.*	*Barrels.*	*Cwts.*	*qrs.*	*lbs.*	*Barrels.*
Year ended 31st December 1872, for Scotland only,	145,976½	...	11,940½	...	...	53,631	,,	,,	...
Year ended 31st December 1873, for do.	160,716½	...	12,381½	...	...	70,101	2	,,	...
Year ended 31st December 1874, for do.	143,466¼	...	6,754	...	...	60,913	,,	,,	...
Year ended 31st December 1875, for do.	187,788½	...	8,503½	...	...	81,880	2	,,	...
Year ended 31st December 1876, for do.	111,457	...	6,109	...	...	59,886	,,	,,	...
Year ended 31st December 1877, for do.	187,200½	...	8,619½	...	...	73,368	2	,,	...
Year ended 31st December 1878, for do.	183,809¼	...	9,219	...	...	94,969	2	,,	...
Year ended 31st December 1879, for do.	162,365	...	8,737	...	...	78,868	2	,,	...
Year ended 31st December 1880, for do.	155,745¼	...	7,794½	...	...	79,946	,,	,,	...
Year ended 31st December 1881, for do.	115,513½	...	4,075½	...	...	61,426	,,	,,	...
Year ended 31st December 1882, for do.	121,337	...	7,737	...	...	56,497	,,	,,	2
Year ended 31st December 1883, for do.	120,335¾	...	7,310	...	...	56,525	2	,,	...
Year ended 31st December 1884, for do.	124,506½	...	5,907½	...	...	56,716	1	,,	...
Year ended 31st December 1885, for do.	125,352½	...	7,100	...	...	47,241	,,	,,	...

N.B.—The Books of this department do not exhibit the Total Quantity of Cod, Ling and Hake *Cured* till the Year commencing 5th April 1825. The Bounty, from the commencement of this Abstract to the 5th April 1830, was 4s. per cwt. for Fish cured Dried, and 2s. 6d. per Barrel for Fish cured in Pickle, taken by the Crews of Vessels or Boats *not* on the Tonnage Bounty; while the Bounty for Vessels licensed for the Cod and Ling Fishery, on the *Tonnage* Bounty, was 50s. per Ton, for Tonnage and Cargo to the 5th of July 1826; 45s. from thence to the 5th of July 1827; 40s. to the 5th of July 1828, and 35s. to the 5th of April 1830, when the Bounties ceased altogether.

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX C.—(See separate Table hereto appended).

APPENDIX D.—TABLE I.

FISHERY STATISTICS.—Account of the Number of Boats, Decked and Un-decked, *irrespective* of the places to which they belong, employed in the Herring Fishery in SCOTLAND, in the Season of 1885, in a selected Week for each District; with the Number of Fishermen and Boys by whom manned; of Coopers, Gutters, Packers, and Labourers employed at the said Fishery in the Week so selected; and the Total Number of all such Fishermen and other persons so employed.

Districts where the Boats were employed at the Herring Fishery.	Boats.	Fishermen and Boys.	Coopers.	Gutters and Packers.	Labourers.	Total Persons Employed.
Eyemouth, . .	346	1,972	160	1,207	318	3,657
Leith, . . .	62	340	39	166	58	603
Anstruther, . .	220	1,320	78	320	100	1,818
Montrose, . .	114	742	84	456	55	1,337
Stonehaven, . .	91	637	49	300	47	1,033
Aberdeen, . .	378	2,457	150	1,413	242	4,262
Peterhead, . .	722	4,332	427	2,609	254	7,622
Fraserburgh . .	888	6,055	460	3,075	519	10,109
Banff, . .	109	682	75	482	58	1,297
Buckie, . . .	94	559	41	293	30	923
Findhorn, . .	50	285	19	159	17	480
Cromarty, . .	30	180	9	93	9	291
Helmsdale, . .	93	510	37	271	20	838
Lybster, . . .	112	668	42	344	62	1,116
Wick, . . .	483	3,139	257	1,654	285	5,335
Orkney Isles, . .	260	1,699	100	803	52	2,654
Shetland Isles, . .	825	4,888	391	3,011	102	8,392
Stornoway, . .	1,081	6,542	329	2,705	181	9,757
Loch Broom, . .	230	920	18	200	8	1,146
Loch Carron and Skye,	265	795	42	279	31	1,147
Fort William, . .	197	590	9	318	20	937
Campbeltown, . .	402	1,206	21	39	60	1,326
Inveraray, . .	264	918	4	...	50	972
Rothesay, . .	185	555	9	48	20	632
Greenock, . .	239	723	...	...	18	741
Ballantrae, . .	411	1,644	60	104	189	1,997

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX D.—TABLE II.

FISHERY STATISTICS.—ACCOUNT of the Number and Tonnage of Boats, Decked and Undecked, and Beam Trawl Vessels, employed in the Herring and other Sea Fisheries of SCOTLAND, in the year 1885, with the Districts to which they belong; the Number of Fishermen and Boys by whom manned; the Number of Fish-Curers, Coopers, and other Persons employed; with the estimated Value of Boats, Beam Trawl Vessels, and Fishing Material.

DISTRICTS.	FISHING BOATS. First Class 30 feet keel and upwards.		Second Class, from 18 to 30 feet keel.		Third Class, under 18 feet keel.		Beam Trawl Vessels.		Total.		Fishermen and Boys.	Fish-Curers.	Coopers.	Other Persons (*Estimated*).	Total Persons employed.	Value (*Estimated*) of— Boats and Bm. Trawl Vessels.	Nets.	Lines.	Total.
	Number.	*Tons.*	*Number.*	*Tons.*	*Number.*	*Tons.*	*Number.*	*Tons.*	*Number.*	*Tons.*	*Number.*	*Number.*	*Number.*	*Number.*	*Number.*	£	£	£	£
Eyemouth,	287	4,792	203	1,217	95	190	1	101	586	6,300	1,572	61	160	2,551	4,344	41,827	36,714	6,579	85,120
Leith,	210	4,949	305	1,578	49	124	22	550	586	7,201	1,925	21	59	2,427	4,432	105,986	42,436	6,922	155,344
Anstruther,	606	11,491	242	1,029	104	228	2	136	954	12,884	3,867	52	78	2,144	6,141	87,528	101,423	14,246	203,197
Montrose,	218	4,892	216	999	199	292	5	210	638	6,393	1,441	14	84	1,777	3,316	60,496	29,569	9,102	99,167
Stonehaven,	91	1,392	39	156	74	148	...	...	204	1,696	513	31	49	666	1,259	11,250	10,322	3,326	24,898
Aberdeen,	117	1,872	124	744	38	76	15	1,425	294	4,117	923	42	150	3,419	4,534	48,870	17,126	3,730	69,726
Peterhead	304	5,728	173	944	82	240	...	...	559	6,912	1,923	93	429	3,779	6,224	53,822	41,740	5,888	101,450
Fraserburgh,	361	6,859	79	474	281	843	...	...	721	8,176	2,376	86	460	4,539	7,461	49,427	59,039	7,250	115,716
Banff,	282	5,640	60	360	218	654	...	...	560	6,654	1,628	33	76	1,071	2,808	30,664	23,090	4,880	58,634
Buckie,	680	12,240	23	115	145	435	...	...	848	12,790	4,031	26	74	3,238	7,369	111,000	107,800	17,537	236,337
Findhorn,	348	6,127	97	514	32	64	...	...	477	6,705	2,306	26	56	1,862	4,250	53,018	50,394	4,470	107,882
Cromarty,	133	2,009	112	484	65	138	...	...	310	2,631	993	6	17	1,354	2,370	12,000	25,130	2,600	39,730
Helmsdale,	125	1,661	57	295	33	86	...	...	215	2,042	768	17	40	373	1,198	7,501	12,560	1,439	21,500
Lybster,	165	2,623	14	72	30	45	...	...	209	2,740	1,032	12	42	446	1,532	8,755	13,958	853	23,566
Wick,	398	7,559	56	382	353	1,053	...	...	807	8,994	2,946	80	269	3,540	6,835	56,201	46,720	3,214	106,135
Orkney Isles,	182	2,836	25	179	431	954	...	...	638	3,969	2,584	37	100	1,115	3,836	19,230	12,355	1,969	33,554
Shetland Isles,	349	5,335	115	230	243	243	...	...	07	5,808	3,191	89	379	3,953	7,612	45,800	28,328	5,069	79,197
Stornoway,	187	2,992	445	2,849	733	2,199	...	...	1,365	8,040	5,390	38	80	2,576	8,084	35,235	26,732	9,894	71,861
Loch Broom	77	1,155	43	296	617	1,851	...	...	737	3,302	2,362	35	18	1,055	3,470	8,599	15,705	2,205	26,509
Loch Carron and Skye,	29	555	277	1,155	654	1,350	...	...	960	3,060	2,910	41	42	578	3,571	7,013	24,167	3,335	34,515
Fort William,	36	392	128	547	424	901	...	...	588	1,840	1,169	67	9	632	1,877	4,204	3,349	639	8,252
Campbeltown,	76	1,278	445	2,177	177	354	7	84	705	3,893	1,798	37	26	609	2,470	26,158	19,059	962	46,179
Inveraray,	13	220	389	2,192	211	422	...	...	613	2,834	1,337	30	5	374	1,746	16,793	14,505	1,696	32,994
Rothesay,	27	405	211	1,052	125	275	...	...	363	1,732	617	24	9	300	950	9,426	11,272	300	20,998
Greenock,	2	24	166	647	114	114	12	105	294	890	457	38	31	879	1,405	4,306	4,679	593	9,578
Ballantrae,	6	75	267	1,039	280	328	41	246	594	1,688	1,038	94	64	747	1,943	8,787	6,554	1,066	16,407
Total,	5,309	95,101	4,311	21,726	5,807	13,607	105	2,857	15,532	133,291	51,097	1,130	2,806	46,004	101,037	923,956	784,726	119,764	1,828,446

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM *Secretary.*

APPENDIX D.—TABLE III.

FISHERY STATISTICS.—ACCOUNT of the Tonnage of Shipping, and of the Number of Seamen engaged in the Trade of the Herring and Cod and Ling Fisheries of SCOTLAND, in the year 1885; distinguishing those employed in Importing Stave Wood, Hoops, and Salt; in Carrying Herrings or Cod Fish coastwise; or Exporting them abroad; and distinguishing British from Foreign Tonnage and Men.

DISTRICTS.	TONNAGE AND MEN.																			
	Importing Stave Wood and Hoops for the Fisheries.				Importing Salt for the Fisheries.				Carrying Herrings or Cod Fish Coastwise.				Exporting Herrings or Cod Fish.				Total.			
	British.		Foreign.		British.		Foreign.		British.		Foreign.		British		Foreign.		British.		Foreign.	
	Tons.	Men.	Tons.	Men.	Tons.	Men.	Tons.	Men.	Tons.	Men.	Tons.	Men.	Tons.	Men.	Tons.	Men.	Tons.	Men.	Tons.	Men.
Eyemouth,	118	8	128	8	2,072	131	...	...	663	50	...	...	258	16	259	14	3,111	205	387	22
Leith,	180	9	250	13	165	10	...	...	720	50	...	...	6,335	451	3	1	7,400	520	253	14
Anstruther,	274	16	642	38	297	16	...	...	...	...	...	...	...	...	...	...	571	32	642	38
Montrose,	154	10	63	4	1,095	58	...	...	150	18	...	...	1,350	59	539	31	2,749	145	602	35
Stonehaven,	...	...	...	...	1,065	28	...	...	36	3	...	...	155	9	1,139	58	1,256	40	1,139	58
Aberdeen,	9,927	602	686	46	2,610	160	...	...	1,060	72	...	...	7,436	255	886	44	21,033	1,089	1,572	90
Peterhead,	404	24	2,177	125	6,189	360	1,011	45	560	37	...	...	5,694	280	13,838	585	12,847	701	17,026	755
Fraserburgh,	574	29	2,074	190	9,295	484	327	16	735	44	...	...	10,574	523	11,103	526	21,178	1,080	13,504	642
Banff,	...	...	140	7	1,192	65	...	...	245	47	...	...	1,117	63	921	46	2,554	175	1,061	53
Buckie,	...	...	40	4	518	32	...	...	...	...	...	...	456	24	1,050	50	974	56	1,090	54
Findhorn,	...	...	...	...	168	9	...	...	...	...	...	...	487	27	150	6	655	36	150	6
Cromarty,	100	14	...	...	119	9	...	...	224	8	...	...	111	6	151	7	554	37	151	7
Helmsdale,	155	9	91	4	388	28	...	...	96	7	...	...	1,131	69	306	16	1,770	113	397	20
Lybster,	...	...	147	8	181	11	...	...	70	14	...	...	1,190	69	463	29	1,441	94	610	37
Wick,	1,236	82	2,325	142	3,462	218	534	34	989	90	...	...	2,997	195	6,056	329	8,684	585	8,915	505
Orkney Isles,	...	...	156	10	5,670	277	...	...	1,170	75	...	...	4,096	231	1,314	70	10,936	583	1,470	80
Shetland Isles,	210	11	310	16	17,432	946	112	6	8,100	405	...	...	21,215	1,188	11,716	558	46,957	2,550	12,138	580
Stornoway,	400	25	1,380	96	4,300	323	360	20	15,455	949	...	...	5,404	321	687	28	25,559	1,618	2,427	144
Loch Broom,	45	9	...	...	488	43	...	...	650	68	...	...	...	...	...	...	1,183	120	...	...
Loch Carron and Skye,	...	...	...	...	923	71	...	...	2,339	144	...	...	111	10	...	...	3,373	225	...	...
Fort William,	...	...	...	...	760	64	...	...	1,060	85	...	...	...	...	...	...	1,820	149	...	...
Campbeltown,	...	...	...	...	223	18	...	...	5,921	259	...	...	60	15	...	...	6,204	292	...	...
Inveraray,	...	...	...	...	140	6	...	...	1,280	124	...	...	...	...	...	...	1,420	130	...	...
Rothesay,	...	...	...	...	230	17	...	...	700	59	...	...	...	...	...	...	930	76	...	...
Greenock,	90	6	...	...	1,185	64	...	...	1,180	62	...	...	1,218	65	...	...	3,673	197	...	...
Ballantrae,	...	...	...	...	158	13	...	...	50	12	...	...	...	...	...	...	208	25	...	...
Total,	13,867	854	10,609	621	60,325	3,461	2,344	121	43,453	2,682	...	...	71,395	3,876	50,581	2,398	189,040	10,873	63,534	3,140

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX D.—TABLE IV.

FISHERY STATISTICS.—ABSTRACT ACCOUNTS, showing the Tonnage of Vessels and Number of Men, the Tonnage of Boats and Number of Fishermen and Boys, and the Number of other Persons employed in the Herring, Cod and Ling, and other Sea Fisheries of SCOTLAND, in the Year 1885.

ABSTRACT.	Tonnage of Vessels and Number of Men.				Tonnage of Boats, and Number of Fishermen and Boys.		Number of other Persons.	Total Tonnage and Persons Employed.			
	British.		Foreign.					British.		Foreign.	
	Tons.	Men.	Tons.	Men.	Tons.	Fishermen and Boys.		Tons.	Persons.	Tons.	Persons.
Total of Herring Fishery Account, Appendix A—Table I., . .	3,314½	498	...	...	...	...	...	3,314½	498	...	...
Total of Cod and Ling Fishery Account, Appendix B—Table I.	3,157	599	...	...	...	...	...	3,157	599	...	...
Total of Fishery Statistics Account, Appendix D—Table II., . .	...	...	...	...	133,291	51,097	49,940	133,291	101,037 102,134	...	...
Total of Fishery Statistics Account, Appendix D—Table III., . .	189,040	10,873	63,534	3,140	...	...	...	189,040	10,873	63,534	3,140
Total,	195,511½	11,970	63,534	3,140	133,291	51,097	49,940	328,802½	113,007	63,534	3,140

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX D.—TABLE V.

FISHERY STATISTICS.—ACCOUNT of the Number of Lives lost in connection with the Sea Fisheries of Scotland; the Number of Boats totally wrecked, and Value thereof; the Number of Boats damaged, and Amount of Damage; and the Loss on Nets and other Fishing Material lost or damaged, in the Year 1885.

DISTRICTS.	Lives Lost.	Boats totally Wrecked, and Value thereof.		Boats Damaged, and Amount of Damage.		Gross Loss on Boats totally Wrecked or Damaged.	Loss on Nets and other Fishing Material Lost or Damaged.	Gross Total Loss on Boats, Nets, &c., Lost or Damaged.
	Number.	*Number.*	£	*Number.*	£	£	£	£
Eyemouth,	7	4	415	1	25	440	2,415	2,855
Leith,	2	3	9,700	7	185	9,885	6,053	15,938
Anstruther,	2	1	30	5	112	142	905	1,047
Montrose,	...	1	200	5	20	220	5,842	6,062
Stonehaven,	5	1	18	1	4	22	811	833
Aberdeen,	11	2	2,150	3	35	2,185	5,820	8,005
Peterhead,	...	...	...	4	120	120	1,439	1,559
Fraserburgh,	14	3	300	8	141	441	4,484	4,925
Banff,	...	...	...	9	114	114	552	666
Buckie,	7	3	47	3	22	69	919	988
Findhorn,	3	3	30	2	25	55	655	710
Cromarty,	...	4	170	1	10	180	312	492
Helmsdale,	...	...	...	...	...	...	200	200
Lybster,	...	2	50	...	...	50	515	565
Wick,	11	2	180	4	47	227	4,686	4,913
Orkney Isles,	15	2	490	8	78	568	1,342	1,910
Shetland Isles,	5	3	460	5	55	515	3,870	4,385
Stornoway,	29	8	106	15	101	207	489	696
Loch Broom,	1	1	300	...	...	300	100	400
Loch Carron and Skye,	6	4	42	7	28	70	699	769
Fort William,	1	2	13	14	36	49	150	199
Campbeltown,	6	...	...	1	10	10	290	300
Inveraray,	...	...	...	5	64	64	410	474
Rothesay,	...	1	30	2	5	35	404	439
Greenock,	...	...	...	2	10	10	374	384
Ballantrae,	1	1	33	...	...	33	78	111
TOTAL,	126	51	£14,764	112	£1,247	£16,011	£43,814	£59,825

Fishery Board for Scotland,
Edinburgh, 1st May 1886.

DUGALD GRAHAM, *Secretary.*

APPENDIX E.—No. I.

HARBOUR ACCOUNTS.—ACCOUNT of the RECEIPT and EXPENDITURE by the Fishery Board for Scotland for Building and Repairing PIERS and HARBOURS, and for TELEGRAPHIC EXTENSION to Remote Fishery Districts (5 George IV. cap. 64, and *ex* Herring Brand Fees), Year ended 31st December 1885.

Dr.

Date		Particulars			
1884.					
Dec. 31.	To	Balance at this date,			£449 8 0
		PIERS AND HARBOURS.			
1885.		*St Monance Harbour, Fifeshire.*			
Jan. 16.	To	Cash received for stones and cement left over at the works,	£2 11 0		
Feb. 14.	„	Net proceeds of sale of plant used at the works,	52 4 6		
					54 15 6
		TELEGRAPHIC EXTENSION.			
		St Mary's (Holm), Burray and St Margaret's Hope, Orkney.			
Sept. 19.	To	guarantee received from Mr John Laughton, Blanster, St Margaret's Hope, to meet his proportion of the deficit in receipts from inland messages forwarded during the year ended 3rd August 1885, from the telegraph offices established at St Mary's, Burray, and St Margaret's Hope,	£70 19 6		
		Castlebay, Barra.			
Nov. 4.	„	Transference from 'Grant in aid of Telegraphic Extension' of proportion chargeable against that grant of deficit in receipts from inland messages forwarded during the year ended 30th September 1885, from the telegraph office established at Castlebay, £131 12 0			
„ 9.	„	Guarantee received from Lady Gordon Cathcart to meet her proportion of the above deficit, 116 15 8			
			248 7 8		
					319 7 2
		BANK INTEREST.			
June 30.	„	Bank Interest on Piers or Quays Deposit Accounts, viz.:— 1. Piers or Quays Deposit Account (5 Geo. IV. cap. 64, and *ex* Herring Brand Fees), year to 31st March 1885,	£20 3 3		

Cr.

Date		Particulars		
		PIERS AND HARBOURS.		
1885.		*Engineers' Travelling Expenses.*		
June 16.	By	Engineers' travelling expenses, year ended 31st March 1885,		£43 5 4
		Stonehaven Harbour, Kincardineshire.		
Oct. 13.	„	Expenses incurred by Chairman and Mr Williamson, M.P., a member of the Board, in visiting Stonehaven Harbour with view to reporting thereon,		4 18 0
		Harbours in Island of Lewis.		
Dec. 12.	„	Expenses incurred by Secretary of Board during inspection, along with engineers, of harbours and creeks in Lewis, with view to reporting to Government on harbour accommodation there,		8 4 0
		Rosehearty Harbour, Aberdeenshire.		
„ 31.	„	Payments for the harbour works at Rosehearty during the year ended this date, viz.:— Works,		55 19 0
		Ness Harbour, Island of Lewis.		
„ 31.	„	Payments for the harbour works at Ness during the year ended this date, viz.:—		
		Works,	£486 15 8	
		Engineers' fees, balance for the whole works,	76 4 4	
				563 0 0
		St Monance Harbour, Fifeshire.		
„ 31.	„	Payments for the harbour works at St Monance during the year ended this date, viz.:—		
		Works,	£2 11 4	
		Engineers' fees for whole works,	87 12 3	
				90 3 7

2. Piers or Quays Deposit Account (*ex* Herring Brand Fees) from 1st April to 1st August 1884, when the two accounts were amalgamated, ... 17 3 3 — 37 6 6

PARLIAMENTARY GRANTS.

Mar. 31.	To Parliamentary Grant for Piers or Quays (5 Geo. IV. cap. 64), year ending this date, . . .	£3000 0 0		
„ „	„ Parliamentary Grant for Piers or Quays and Telegraphic Extension (*ex* Herring Brand Fees, 1883):—			
	For Piers or Quays, . £800 0 0			
	„ Telegraphic Extension, 1000 0 0	1,800 0 0	4,800 0 0	
				£5,660 17 2

Crovie Landing Slip, Banffshire.

„ 31.	„ Payments for the works at Crovie during the year ended this date, viz.:—			
	Works, ...	£384 10 0		
	Engineers' fees, ...	49 19 6		
	Inspector's wages, ...	46 17 6	481 7 0	
			£1,246 16 11	

TELEGRAPHIC EXTENSION.

1885.	*St Mary's (Holm), Burray, and St Margaret's Hope, Orkney.*			
Sept. 18.	By Guarantee paid to H.M. Postmaster General to meet the deficit in receipts from inland messages forwarded during the year ended 3rd August 1885, from the telegraph offices established at St Mary's, Burray, and St Margaret's Hope, ...	£212 18 6		
	Castlebay, Barra.			
Nov. 4.	„ Guarantee paid to H.M. Postmaster General to meet the deficit in receipts from inland messages forwarded during the year ended 30th September 1885, from the telegraph office established at Castlebay, . .	645 1 0		
	Walls and Reawick, Shetland.			
Dec. 12.	„ Guarantee paid to H.M. Postmaster General to meet the deficit in receipts from inland messages forwarded during the year ended 9th September 1885, from the telegraph offices established at Walls and Reawick,	163 1 3	1,021 0 9	
„ 31.	„ Balance at this date, ...		3,392 19 6	
			£5,660 17 2	

Fishery Board for Scotland,
Edinburgh, 1st May 1886

DUGALD GRAHAM, *Secretary.*

APPENDIX E.—No. II.

REPORT by the ENGINEERS upon the State of the HARBOUR WORKS in progress under the FISHERY BOARD FOR SCOTLAND during the Year 1885.

We have now the honour to submit the following Report on the Harbour Works in progress during the year 1885 :—

Crovie Landing Slip, Banffshire.—The works connected with the landing slip at the fishing creek of Crovie, which were suspended during the winter of 1884–5, were completed in September last. The slip is 234 feet in length, extending from the beach to low water of spring tides. Previous to the erection of the slip there was an entire absence of any facilities for prosecuting the fishings, the boats after the fish had been discharged requiring to be hauled up on arriving, the ballast thrown out, and again put on board before going to sea. The very limited funds at disposal admitted only of providing this landing slip at which boats might be enabled to land in good weather, preserve their ballast, and be hauled up in security.

Ness Harbour, Island of Lewis.—The works at Ness have been completed. As mentioned in last year's Report, this small harbour is built on an exposed sandy coast, and, like all such harbours, is liable to have sand thrown into it by storms. The accumulations of sand have proved even more troublesome than was anticipated. The object for which this harbour was made, and which it amply fulfils, was to afford shelter in heavy weather to the small class of boats used by the local fishermen, and to save them the labour of drawing their boats out of the water above high water mark, as they had to do every time they came in. The harbour has, however, been largely taken advantage of by strangers, and would evidently become a fishing centre of some importance if there were room and depth of water for the large class of boats used by strangers coming from the South and the East Coast. The only way to meet this want is to make an entrance to the eastward of the present one, and this would also, to some extent, prevent the present accumulation of sand in the harbour. This entrance was very fully discussed when the original design was made out, but the expense of the necessary works, and the limited funds at disposal, prevented its being adopted. The present harbour is, however, so laid out as to form an integral part of such works should funds be forthcoming to execute them.

Harbours in the Island of Lewis.—At the request of His Grace the Duke of Richmond and Gordon, late Secretary for Scotland, and with the concurrence of the Board, a preliminary inspection of certain sites for fishery harbours, in the Island of Lewis, was made in November last, and the result given in our Report of 10th December, to which we beg to refer.

D. & T. STEVENSON.

EDINBURGH, *6th February* 1886.

APPENDIX F.—No. I.

ON THE DEVELOPMENT OF THE HERRING. PART II. By GEORGE BROOK, F.L.S., Lecturer on Comparative Embryology in the University of Edinburgh. (Plates I. and II.)

THE EARLY STAGES OF DEVELOPMENT.

THE egg of the herring is one which offers several advantages to the student of fish development. Not the least of these is derived from the fact that the germinal disc is only formed after fertilisation, so that it may actually be watched in process of formation. The conclusions which I have been led to regarding the development of the herring are, generally speaking, in harmony with those of Kupffer. That investigator had not, however, the advantage of studying a complete series of sections of the ova; and where my observations differ in any important degree from his, the difference is, I think, mainly to be attributed to this fact.

A detailed account of my observations, and of the theoretical considerations suggested by them, has been brought before the Royal Society of Edinburgh. It will therefore only be necessary to give here a short account of the experiments conducted in connection with the fertilisation of the eggs and of the additional information which has been obtained by a renewed study of the development of this most important food fish.

My thanks are due to the directors of the Rothesay Aquarium for the readiness with which they placed their establishment at my service for these experiments, and to their manager (Mr Shields) for the valuable assistance which he rendered.

1. *Experimental Work.*

For the purposes of my investigations a considerable number of ripe herring were obtained from the Ballantrae Banks in March last, and conveyed alive to Rothesay on board H.M.S. 'Jackal.' The herring were then safely transferred to the tanks of the Rothesay Aquarium for further study. The fish were under observation for a month, but gradually died off, as they were unable to withstand the rough usage and handling necessitated by the experiments.

Of eight different batches of eggs that were under observation, seven were fertilised artificially, and the eighth was shed by the fish in transit. As Professor Ewart has already pointed out, there is little difficulty in fertilising the ova of the herring artificially, and my recent experiments in this respect were very satisfactory. There appears no reason why this could not be accomplished on a large scale.

Previous authors are not agreed as to the action which the spermatozoon has on the ripe ovum. Kupffer (1), after repeated experiments, concludes :—

1. That the herring ovum shows at the moment it reaches the water from the oviduct no trace of a germinal disc, or indeed any separation into formative and nutritive yolk.

2. That water *per se* alters nothing in the relations of the yolk, nor of the egg membrane with the yolk. No water enters through the egg membrane, nor does the latter separate from the yolk after immersion in water for twenty-four hours.

3. If, however, the water in which the eggs are deposited is previously supplied with milt, or if the milt is added some hours after the eggs have

been laid, in about fifteen minutes the egg membrane separates from the yolk, and a clear space appears between the two. A series of complicated phenomena now take place in the yolk, which results in the separation of formative and nutritive yolk, and finally in the concentration of the former at one pole as the *germinal mound.*

4. Spermatozoa enters the egg in *great numbers,* and not at one point only, but *on all sides.*

5. The germinal disc is thus formed under the combined influence of sea-water and sperm.

Boeck's observations (2) are in harmony with those of Kupffer, excepting that he states that, *whether the egg is fertilised or not,* a portion of the yolk becomes transformed into the germinal disc and undergoes a partial segmentation.

Hoffman (3) combats Kupffer's view that the germinal protoplasm is formed under the combined influence of sea-water and sperm, and maintains that in the herring, as in other teleostean fish, the germinal layer exists before fertilisation.

Kupffer suggests that the salinity of the water may have some influence on the egg membrane, and that possibly it may in certain cases be thus rendered permeable without the previous influence of spermatozoa.

I have therefore performed a series of experiments to test the above statements. These were carried on in water which had a specific gravity of 1·24, and at a temperature varying from 41·8° F. to 44·9° F. Kupffer's observations were made at Kiel in water containing only 0·3 – 0·4 per cent. of salts; Boeck, on the other hand, used water containing 3 per cent. of inorganic salts.

The following is a list of the more instructive of the experiments which were performed at Rothesay.

Experiment 1.—In order to ascertain if the ova and milt retain their vitality a considerable period after the death of the fish, a number of herring were placed in moist cloths immediately after death, so as to prevent the eggs from drying up. A number of ova were mixed with milt twelve hours after the death of both fishes, at 3 p.m., 14/3/85. There was no change in any of the ova at 10·30 a.m. next day, and all were evidently unfertilised.

Experiment 2.—Eggs were taken from the same female as in experiment 1, thirteen hours after death, and mixed with milt from a living male at 4 p.m., 14/3/85. Within an hour the egg membrane had separated from the yolk in almost all the eggs, and next morning development was going on quite normally.

Experiment 3.—Eggs were taken at 11 a.m. from a living female and allowed to remain in sea-water an hour before the milt was added, in order to allow the viscous covering of the egg envelope to harden. During this time a few eggs began to develop a *breathing chamber,* but the majority did not alter at all. [Kupffer asserts positively that a breathing chamber is *never* formed in the egg of the herring until after the penetration of the spermatozoa. Possibly a few living spermatozoa may have been in the water used in this experiment, as it was taken from one of the tanks in the aquarium.] At noon living milt was added, and in half an hour the majority of the eggs were developing a breathing chamber, after which development went on normally.

Experiment 4.—Ova were taken from a fish that had been dead forty-eight hours, and milt added from a living male. A separation of the egg membrane from the yolk took place in about 50 per cent. of the eggs some hours afterwards, and in a few the early stages of segmentation were gone through, but somewhat abnormally.

Experiment 5.—Ova were taken from a living female and placed in a beaker of water taken direct from the sea, so as to be sure it contained no spermatozoa, there being no herring in the neighbourhood of Rothesay Bay at the time. Twenty-four hours afterwards all the eggs were still unchanged. *There was no separation of the egg membrane from the yolk in any of the ova.*

Experiment 6.—In this experiment the same ova were used as in experiment 5. After remaining unchanged in sea water for twenty-four hours they were mixed with living milt. A few hours afterwards a breathing chamber was formed at one pole in nearly all the eggs, and the egg capsule was thinned out at the opposite pole. There was, however, no further development.

Experiment 7.—In order to ascertain if active spermatozoa were to be found in any of the tanks adjoining those in which the living herring were kept, eggs were taken from a living female and placed in water from an adjoining tank. Care was taken that no spermatozoa were introduced during the experiment. Next day a small percentage of the eggs were developing quite normally, but the majority remained unchanged.

Experiment 8.—Ova from a female which had only been dead a short time were mixed with milt from a male that had been dead three hours. Next day a few of the ova were developing quite normally, but the majority remained unchanged.

The foregoing experiments appear to justify the following conclusions:—

1. The ova retain their vitality, and are capable of being fertilised from forty to forty-eight hours after the female is dead. In the experiments performed forty-eight hours seems to be a little outside the limit at which the eggs are capable of being fertilised, but it is probable that temperature may have an influence on the vitality of the ova.

2. The spermatozoa do not retain their vitality for nearly so long a period. Three hours appears to be the limit indicated by the above experiments.

3. The egg capsule never separates from the yolk excepting under the influence of spermatozoa. It would appear that when the ova and spermatozoa have partly lost their vitality a partial separation of the egg membrane from the yolk may take place, although the ovum is not truly fertilised. Experiment 5 shows conclusively that the egg capsule is not permeable to water until after it has been penetrated by spermatozoa.

4. The egg membrane is covered with a viscous secretion when the ovum leaves the oviduct, which serves for the attachment of the ovum. This viscous layer gradually hardens in sea-water. Active spermatozoa are able to penetrate this layer some hours after it has set, but this power appears to be confined to the first twenty-four hours after deposition.

5. There is no collection of germinal protoplasm at the surface of the yolk in the ripe ovarian ovum, nor is a germinal disc ever found so long as an ovum remains unfertilised. The formation of the germinal disc cannot be made out in living ova, and its true nature can only be determined from a study of sections.

2. *Formation of the Blastoderm.*

I have already summarised Kupffer's conclusions on this subject in the first part of this paper (Third Annual Report S.F.B., 1884). My observations do not coincide with his on many points, but the chief differences are to be explained, I think, by the fact that Kupffer had not an opportunity of examining sections in the earlier stages. In the ripe

unfertilised ovum the germinal protoplasm is distributed throughout the yolk, and it does not mingle with the food material, but forms a network filling up the spaces between the yolk spheres. An examination of sections of the ovum shows that the conclusions arrived at in the experimental work are justified, and that the germinal protoplasm does not collect at the surface of the yolk until after fertilisation. Kupffer asserts that at the time the egg reaches the sea-water from the oviduct there is no trace of a germinal disc, nor even any separation into formative and nutritive yolk. With the first part of this statement I thoroughly agree. In the ordinary sense of the word there is no germinal *disc* in the ripe unfertilised ovum. The germinal protoplasm nevertheless exists, but being generally distributed instead of forming a special aggregation at one part, it is not easily made out in the living egg. This has been already pointed out by Hoffmann, though I am inclined to think that he also has not thoroughly understood the formation of the germinal disc in the herring, or rather what I shall term the *germinal mound.*

Soon after fertilisation the first change to be noted is the separation of the egg membrane from the yolk. This commences at first in one part only, but quickly extends all around the egg, so that the vitellus comes to lie loosely in an enlarged egg capsule. The space between the two is filled with water, in which a portion of the egg contents is dissolved. This space is the *perivitelline space,* the *breathing chamber* of Ransome. The increase in diameter which results from the inception of sea-water is about ·35 mm. The unfertilised egg averages 1·17 mm. in diameter, and when the breathing chamber is completely formed this diameter is increased to 1·52 mm.

As the egg membrane leaves the yolk the surface of the latter can be more easily studied. It is then seen that the 'yolk granules' on the surface are rapidly disappearing. The neighbouring granules run together and flatten out into a thin pellicle, which soon becomes indistinguishable on the surface of the larger yolk spheres. The germinal protoplasm now collects to the surface of the yolk. Having failed to recognise the network of germinal protoplasm in the unfertilised egg, Kupffer concluded that the protoplasm of the germinal mound is derived almost solely from the vitellus after fertilisation. He describes the first stage in the process as the formation of a series of *clear vacuoles* on the surface of the yolk, which have the appearance of small transparent spots. These increase rapidly in size, and are pushed forward towards the centre of the yolk as a coarse network of tubes. With the appearance of the clear vacuoles the germinal protoplasm begins to collect on the surface of the yolk. According to my own observations I am led to reverse the process, and to conclude that the tube-like structures do not grow from the surface downwards, but are present in the unfertilised egg, and are gradually withdrawn into the surface layer. With the act of fertilisation an activity is set up in the germinal protoplasm, which causes it to collect rapidly at the surface. Very early in this process the outer yolk spheres are a little wider apart than those towards the centre, and the protoplasm as it collects widens and fills up the spaces between them A little later the protoplasm is almost entirely withdrawn from the centre of the egg, and there is then a thin layer of germinal protoplasm on the surface, with a number of branched root-like processes extending some distance into the yolk. It is, I think, this collecting protoplasm which Kupffer has mistaken for vacuoles and his series of coarse tubes. To begin with, the protoplasm forms a network throughout the yolk. After fertilisation the protoplasm collects at the surface, and in doing so the more peripheral strands increase in thickness at the expense of those more centrally

situated. The branching root-like processes are therefore not pushed down from the surface, but are part of the germinal protoplasm, which has not yet been included in the surface layer. In sections of the egg at this stage, which have been mounted unstained, the germinal protoplasm is very transparent, whereas the yolk spheres are quite granular, and of a yellowish tint. This accounts for the tubular appearance of the channels seen in the living egg.

In the unfertilised ovum the protoplasm always collects more or less at the surface after a time, but its behaviour is quite different to that in the fertilised ovum. So long as an ovum remains unfertilised the germinal protoplasm acts as so much passive matter. It collects slowly at the surface, and day by day the protoplasmic network is withdrawn more and more from the centre. The collection goes on equally all round, and the protoplasm does not appear to be withdrawn to a greater extent in one part than in another. After a week's immersion in salt water a section of an unfertilised egg only differs from that shown in fig. 19, in having more protoplasm at the surface and less in the centre. The protoplasmic filaments are, however, never so completely withdrawn in the unfertilised as in the fertilised egg. It should be pointed out that this partial collection of the germinal protoplasm at the surface takes place *whether the egg is placed in sea water or not.* In order to conduct the experiments already referred to (p. 31) ripe females were kept for a varying time in moist cloths, and eggs were pressed from the genital opening from time to time as they were required. Sections of these eggs showed that the germinal protoplasm begins to collect at the surface of the yolk in a passive manner soon after the egg is ripe, and that the amount of protoplasm found at the surface was, roughly speaking, proportional to the time which had been allowed to elapse before examination. Thus, then, sea water has nothing to do with causing the protoplasm to collect at the surface, nor, so far as I could see, is this accomplished any more rapidly in water than in the ovary itself.

In a batch of eggs which have been fertilised artificially there are always a few which have escaped fertilisation. These can readily be distinguished with the naked eye, partly on account of their greater opacity, and partly because they retain their original size, there having been no inception of water. Such eggs, up to the end of the incubation of the batch, always have the germinal protoplasm more or less distributed throughout the yolk.

Let us return now to a consideration of the behaviour of the fertilised ovum.

At first the protoplasm, as it collects, forms a comparatively even layer around the yolk. Soon, however, it assumes a digestive function, and large masses of yolk are incorporated within its substance and assimilated. During this period the protoplasm exhibits slow undulating movements around the yolk. The protoplasm increases considerably in bulk at the expense of the yolk. After a time the greater part of the protoplasm collects at the germinal pole, and there forms the *germinal mound.* Sections at this stage show that the whole of the protoplasm has not yet been withdrawn from the interior. From the base of the germinal mound, which is not well defined, a number of branching filament press down for a considerable distance between the yolk spheres, and there is always a cortical film of protoplasm around the yolk (fig. 22).

There is frequently a collection of protoplasm at the pole opposite to the germinal mound. It appears that as the protoplasm is preparing to collect at the germinal pole, it oscillates between the two opposite poles

for a short time, and the collection at the yolk pole is sometimes so great that it may easily be mistaken for the true germinal area.

Segmentation now begins; but while it is in progress the portion of protoplasm situated in the base of the germinal mound, and including the processes pushed in amongst the yolk-spheres, continues its digestive function, and, indeed, this process goes on without intermission until the whole of the food-yolk has been absorbed. The first furrow is a vertical one (meridianal). The second is also meridianal in direction, but in a plane at right angles to the first. Neither furrow is, however, pushed down to the base of the germinal mound, as seen in optical section. From what has been said, it will be seen that there is no well-defined limit between protoplasm and yolk, but that the basal portion of the germinal area is a mixture of protoplasm and yolk which is undergoing assimilation.

In the living egg a very interesting phenomenon may frequently be observed, which throws considerable light on the early segmentation stages. It often happens that shortly before the formation of the first furrow a collection of protoplasm is to be noticed at the yolk-pole. As soon as the first traces of a furrow are to be seen this protoplasm sinks, leaves the yolk-pole, and joins that in the germinal area. After the first furrow has been pushed down as far as the intermediate digestive area, a portion of the protoplasm sinks back to the yolk-pole, only to leave it again on the commencement of the second furrow. After the formation of the second furrow a collection of germinal protoplasm is again to be noticed at the yolk-pole.

The appearances here described are not abnormal; the process has been already observed by Kupffer, who suggested the term *gegenhugel* for the collection of protoplasm at the yolk-pole.

In the herring the third furrow takes an equatorial direction. Prior to its formation the protoplasm at the yolk-pole is included in that of the germinal mound, and of necessity the protoplasm remaining in the lower pole is no longer in communication with the segmenting disc. After the formation of the two first furrows the germinal mound was divided into four segments, whose bases were not defined. The third furrow simply completes the bases of these four segmentation spheres, so that they are then shut off from connection with the cortical protoplasm and the yolk. The upper pole is the germinal disc, which goes on segmenting; it constitutes the *Archiblast* of Klein (4).* The lower pole consists of a central mass of yolk, around which is a cortical layer of protoplasm, which is the *Parablast.*

Nothing has hitherto been said as to the behaviour of the nucleus during these early stages of segmentation. As a matter of fact, I have not been able to find a nucleus nor any trace of nuclear division either in the living egg or in sections of prepared material. I have been led, therefore, to conclude that the nuclear material is not collected into a definite recognisable mass in these earliest stages of division, but is generally distributed throughout the germinal protoplasm. The behaviour of the germinal vesicle as the egg increases in size appears to support this view. After the completion of the base of the first four segmentation spheres—that is, after the formation of the first equatorial furrow—a nucleus appears in each of the archiblast cells. This has the appearance of a transparent vacuole-like spot toward the centre of each segmentation sphere, and always disappears before the commencement of each succeeding furrow, to reappear again after the division is complete.

* The term *Archiblast* was originally suggested by His; it is however used here in a more modified sense than was extended to it by that author.

Kupffer concluded that in the pike the second furrow is an equatorial one, and inferred that the same is the case in the herring. Hoffmann, on the other hand, has described the first furrow as equatorial in direction, dividing the germinal protoplasm at the outset into two layers—the archiblast and parablast.

With these exceptions, an equatorial furrow has not hitherto been described at so early a stage in the segmentation of fish ova, though it is possible, from the nature of the furrows, that it has been overlooked. The point, if of general application, has considerable phylogenetic interest. An analogy can thus be instituted between the segmentation of meroblastic ova such as those of fishes, and the holoblastic ova of Amphibia and allied forms. In both cases the first equatorial division of the ovum takes place with the formation of the third furrow, and the ovum then becomes divided into an animal and a vegetative pole. The animal pole is represented in the herring by the archiblast, which goes on segmenting. The vegetative pole consists of only one large cell containing the yolk in the centre, which is surrounded by a thin layer of protoplasm—the parablast. I have endeavoured to explain the cause of this unicellular vegetative pole in a paper which was read before the Royal Physical Society of Edinburgh in January last, so that the subject need not be discussed further here.

The archiblast goes on segmenting in the usual way, while the parablast does not for the time being undergo division, but simply increases in bulk by a further assimilation of yolk. When at first formed the parablast was thickest under the archiblast, but gradually the protoplasm sinks from that area, and collects in a comparatively thick layer around the yolk.

The segmentation in the archiblast takes place to a great extent by a process of vacuolation, and the straight planes of cleavage usually found in karyokenetic cell division seldom occur in the earlier stages. In the future plane of cleavage a number of vacuoles arise, which increase in size and run together, forming larger vacuoles, and in this manner the two adjacent masses of protoplasm become ultimately separated. Before the process is complete the two resulting daughter cells are connected together by bridge-like strands of protoplasm, the substance of which is gradually withdrawn into the daughter cells. I have described the process in detail in a paper 'On the Nature of the Segmentation Process in Fish Ova' (*Proc. Roy. Phys. Soc.* Session 1885–86).

The primary segmentation phase in the archiblast may be said to terminate at a stage corresponding to that shown in fig. 8. An egg at this stage measured 1·4288 mm. in the direction of its long axis, and 1·1656 mm. in the axis at right angles to it. The disc in the same egg was 1·0904 mm. in diameter, and had a greatest thickness (as seen in optical section) of ·3948 mm. The disc extends over 110 degrees of the circumference of the yolk.

The cells which form the morula mass in this stage have hitherto been considered as derivatives of the archiblast only. Such, however, is not the case so far as the herring is concerned, and I have reason to suppose that the herring is not alone in this respect. In a case of this sort a study of the living egg is of little value, and it is absolutely necessary to study a series of consecutive sections in order to understand what takes place. In the interval between the stages shown in figures 7 and 8 the parablast has increased considerably in bulk, and a portion of it is seen in sections to form a comparatively thick layer between the archiblast and the yolk. Nuclei appear in this portion at comparatively regular intervals by the process which has been termed 'free cell formation.' I

use the term in the sense in which Kupffer used it, and can confirm his observations on this point both from a study of the herring and also of other forms. The nuclei in the parablast at this stage are not derived from any pre-existing nucleus *in the ordinary sense of the word.* As Kupffer remarks, they arise from dot-like beginnings and gradually increase in size, and *each is produced independently of its neighbour.* Whether the material of which the nuclei are formed is itself derived in the first instance from the first segmentation nucleus of the ovum is another question. Our knowledge of cells and cell divisions throughout the animal and vegetable kingdom lead undoubtedly to the conclusion that there is no such thing as true free cell formation, that every nucleus must be derived from a pre-existing nucleus. There is no reason why part of the original segmentation nucleus should not be contained within the parablast, when this is separated from the archiblast by the formation of the first equatorial furrow. As a matter of fact, I have not been able to find such a nucleus, and have been led to suppose that its material is generally distributed, and only again becomes aggregated in the form of nuclei in the stage here described. After the formation of these parablast nuclei the protoplasm around them becomes constricted off, so that a number of cells are formed *in situ.* These then become pushed up amongst the cells of the archiblast. At first they are easily distinguished and stain differently, but after a time the difference is lost. The whole of the parablast in this region is not used up in this way, but a part remains which again increases in bulk, while the cells in the disc are undergoing further division. A second batch of cells is added to the disc in a similar manner, and we then have the stage shown in figure 8. Cells next become distinguishable in the portion of the parablast which has remained on the surface of the yolk. This collects around the margin of the disc in the form of a thickened welt, which gradually thins off over the yolk. The appearance in section is shown in figure 10. A row of dot-like nuclei appears in the thickest portion, forming a complete ring. The protoplasm around these nuclei becomes divided off, and a row of cells is produced in the *thickest portion* of the peripheral parablast, as shown in figure 9. The whole process is completely analogous with that described at an earlier stage. Other rows of cells are added as development goes on, until in the stage represented in figure 11 the peripheral parablast has become cellular from the base of the disc to the equator of the egg. Between the stages shown in figures 9 and 11 the disc begins to extend around the yolk. This is accomplished by a thinning out of what was originally the thickest portion of the disc. In figure 10 it will be seen that the base of the disc is flat; the process of extension can easily be followed from a comparison of figures 11 to 14. As the disc begins to spread over the yolk it no longer lies on the parablast in the centre, and a space is thus formed between the two layers, which is the segmentation cavity. This segmentation cavity separates the animal from the vegetative pole. In figure 11 the disc has extended over an arc of 160°, and in its centre has now a thickness of ·3760 mm. In figure 12, where the disc is fast approaching the equator of the egg (it covers an arc of 176°), the diameter of the central portion is only ·1880 mm., and the periphery is almost as thick as the centre. In the next stage (figure 13) the gradual thinning out of the central portion of the disc is still more marked, while the periphery is now the thickest portion. In the next stage it is seen that in optical section the disc is thicker on one side than on the other. This is represented in figure 14. It will be noticed on comparing the figures, that in its extension the disc has gradually spread over the parablast until in the stage shown in figure 14 the whole of the

cellular parablast has been covered. The disc during these changes does not thin out equally in all directions. In the axis of the future embryo a longitudinal band of cells remains, which is several rows deep, and these gradually thin off towards the periphery on both sides, at which there is again a slight thickening. The thickening of cells in the embryonal axis is the 'keel,' and is composed almost solely of cells derived from the segmented disc. Later it increases considerably in thickness, particularly in the anterior region of the embryo. A diagrammatic view of the manner in which the disc extends, as seen in a plane at right angles to the axis of the embryo, is shown in figure 19. Figures 10 to 13 show optical sections of the living egg in the direction of the embryonal axis, and at a plane showing the greateat thickness of the keel.

With the extension of the disc over the yolk the germinal layers are differentiated. The process can be seen in operation in the living egg, but it is only by a study of sections that the nature of the process can be understood. I have reviewed the literature on this subject at length in my paper communicated to the Royal Society of Edinburgh, and will content myself here by simply stating the *modus operandi* as I have observed it in the herring.

I shall speak of the segmented disc as archiblast, although it must be remembered that in the herring this also contains a number of cells derived from the parablast. This is, however, not a constant feature in the development of teleosteans. In retaining the name I have been guided more by the fate of the cells contained within the germinal disc than by a knowledge of their mode of origin. It may be that when the whole subject has been more thoroughly investigated a change of nomenclature will be necessary.

When the segmentation cavity is formed the central portion of the disc is raised up from the parablast, but at the periphery the two layers remain in contact over a distance covered by several rows of cells. When the so-called invagination process takes place a new layer is formed, which may be called the *primitive hypoblast*. The process is not really one of invagination; but, seeing that the new layer commences at the periphery, and extends inwards, the term pseudo-invagination may be applied. The process in the herring is identical with that which I have already described for *Trachinus* and *Motella,* and for which I suggested the term 'segregation' (5). I am not prepared to state that the new layer contains no elements of archiblastic origin, but these are, I think, without doubt chiefly derived from the parablast. This layer forms a polynucleated mass underlying the archiblast. At the periphery, where the two layers are in contact, cells are formed around the nuclei in the parablast, and these attach themselves to the cells of the archiblast. In this way a thickening is produced around the circumference of the archiblast, which is the embryonal rim. In sections of this stage the distribution of the parablast is very instructive. In the region of the thickening the parablast is very thin, and the nuclei, which were previously situated in it, have all been used up. Immediately in front of the thickening the parablast forms a comparatively thick layer, forming the floor of the segmentation cavity, and contains a large number of nuclei. Outside the thickened rim the parablast is also thick, and charged with nuclei. It is evident, therefore, that the nuclei of the parablast and a large part of its protoplasm have been used up, in that portion on which the archiblast rests, to form the thickened rim. Next the new layer extends inwards in the axis of the embryo, the nuclei and protoplasm of the parablast being utilised for the purpose. As the new layer grows inwards, the segmenta-

tion cavity is to a great extent obliterated. In front of the marginal thickening the new layer is not, however, in contact with the archiblast, but a slight fissure separates the two layers. As cells are added from the floor of the segmentation cavity (parablast), the cavity itself is not completely filled up, so that the fissure between the archiblast and primitive hypoblast marks the original extension of the segmentation cavity. It is this fact which I think has led to the conclusion (which is still generally accepted) that the primitive hypoblast is derived by an infolding (invagination) of the archiblast. It has been argued that if the new layer is not derived from an ingrowth from the old one, why should not the separation between the two be complete at the periphery as well as nearer the centre. The reason for the close union of the two layers at the margin appears to me to be clear from an examination of fig. 21. The archiblast in the region of the peripheral rim rests directly on the parablast, so that the cells derived from the latter layer become closely united with those of the archiblast. More centralwards the two layers are separated from one another by the segmentation cavity, and I take it that it is for this reason the cells derived from the floor of the cavity do not unite with those forming its roof. In sections stained with carmine the two layers are quite distinct throughout their whole length. The primitive hypoblast does not stain so deeply, for the reason that the nuclei of very few of its cells are in the resting stage.

While the primitive hypoblast is in process of formation the extension of the whole blastoderm over the yolk becomes more and more marked. At the same time the archiblast, in what may now be distinguished as the caudal region of the embryo, thins out more than that in the anterior region of the body axis (see figure 23). The thickened rim is formed all around the blastoderm, but afterwards there is no increase in the anterior portion. In the posterior portion the new layer grows inwards as a shield-like structure (embryonal shield), thicker in the centre, the cells of which are ultimately collected into the body axis. In the anterior region there is a considerable thickening of the archiblast, which soon becomes distinguishable as the head of the embryo and the primitive hypoblast gradually thins off as it reaches this part. The *anterior* portion of the rim, which in the herring is more elongated than in many other forms, grows downwards over the yolk, leaving behind it a row of archiblast cells, and a row derived from the parablast, the two being separated by a fissure. The cells in the thickening itself are derived from a fusion of the two layers. The method by which the yolk becomes completely enclosed by cells of the blastoderm is practically the same in all teleostean fishes with which I am acquainted, and has been frequently described. In figure 14 the thickened rim is seen to have reached the yolk pole, and a considerable extension of the caudal extremity has also taken place. In figure 15 the yolk is almost completely enclosed, while in figure 17 the thickening which has been pushed down from the anterior extremity has united with the caudal fold. Figure 16 represents a transverse section of the axis of the embryo, shortly prior to the closure of the blastopore. The relation of the layers at about the stage of figure 17 will be understood from a comparison of figure 24, which represents a longitudinal section of the same stage.

I conclude from the examination of a large number of sections that the animal pole of the ovum gives rise to the ectoderm. In many forms the animal pole at the time of the formation of the segmentation cavity consists only of true archiblast cells. In the herring, and probably some other forms (about which I hope to write later), the animal pole receives an addition of cells from the parablast prior to the formation of the segmentation

cavity. The primitive hypoblast, which is almost entirely derived from the parablast (*i.e.*, from the vegetative pole), gives rise to the mesoderm, and the secondary hypoblast (entoderm) remains as a single row of cells in connection with the parablast.

If I am correct in these conclusions, the similarity between the development of teleosteans and amphibians (Rana) cannot fail to be noted. The derivatives of the animal and vegetative poles are in both cases practically identical. The secondary segmentation (budding) in the parablast of teleosteans must then be regarded as the necessary consequence of the relative distribution of protoplasm and yolk in the vegetative pole.

The primitive hypoblast, as here described for the herring, is precisely homologous with that of Amphioxus. In both cases the primitive layer gives rise to mesoderm, notocord, and true entoderm.

The position here brought forward is one which I advocated over a year ago, but from the nature of the material then at my disposal I failed to observe the details of the process. Quite recently, Dr Ruckert (6), who has been studying the behaviour of the parablast in Elasmobranchs, has come to conclusions practically identical with those here advocated for Teleosteans. The chief points of his paper, so far as our present purpose is concerned, are as follows :—

1. In Elasmobranchs the parablast arises with the first equatorial division of the egg.

2. In Torpedo the cells forming the roof of the segmentation cavity (archiblast) give rise to the ectoderm. The nucleated cells of the parablast (merocytes) give rise to the other embryonal layers.

It remains to be seen how far our conclusions are confirmed by future investigations, but it is an interesting fact that two authors working at different groups of fishes should have quite independently arrived at precisely the same conclusion. More particularly is this the case when it is remembered that this conclusion is entirely at variance with the generally-accepted theory on the subject.

LIST OF LITERATURE REFERRED TO IN THIS PAPER.

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(2) Boeck, '*Om Silden og Sildefiskerierne*, &c. (Christiania, 1871).

(3) Hoffmann, *Z. Ontogenie d. Knochenfische* (Amsterdam, 1881).

(4) Klein, 'Early devel. of the Trout (*Quart. Jour. Micros. Science*, 1876).

(5) Brook, 'On the Origin of the Hypoblast in Pelagic Fish Ova (*Quart. Jour. Micros. Science*, 1885).

(6) Ruckert, *Keimblattbildung b. d. Selachier* (Munich, 1885).

EXPLANATION OF PLATES I AND II.

Figure 19 is taken from a drawing made for me by Mr J. T. Thompson, M.B.; for figures 20 to 24 I am indebted to Mr W. L. Calderwood; while all the others have been executed from living specimens by my assistant, Mr Binnie.

Lettering used in the Figures.

A. = archiblast.
A.P. = animal pole.
a. ex. = anterior extremity.
bl. = blastopore.
b.r. = thickened rim blastoderm.
c.p- = cellular parablast.
e.a. = embryonic axis.
ec. = ectoderm
en. = entoderm.
g.d. = germinal disc.
g.p = germinal protoplasm.
g.p.[1] = ditto, collected at vegetative (yolk) pole.
g.p.[2] = germinal processes pressed in amongst the yolk.
h.f.[1] = 1st horizontal (equatorial) furrow.
h.f.[2] = 2nd ditto
k. = keel
l.c.p. = limit of cellular parablast.
me. = mesoderm.
P. = parablast.
p. ex. = posterior extremity.
p.h. = primitive hypoblast.
p.s. = perivitelline space (breathing chamber).
pr. v. = protovertebræ.
s.c. = segmentation cavity.
V.P. = vegetative pole.
v.l. = viscous layer.
y[1] = yolk imbedded in the germinal area which is undergoing assimilation.
y.g. = yolk granules.
y.s. = yolk spheres.
z.r. = zona radiata.

Fig. 1.—Optical section of a living unfertilised egg. The mass of large yolk spheres are best seen towards the centre, while nearer the periphery the small 'yolk granules' are represented by the smaller dots. In this stage the egg envelope adheres closely to the vitellus. The germinal protoplasm is not shown.

Fig. 2.—Ovum 1 hour after fertilisation. There is a collection of germinal protoplasm at the surface of the yolk; the 'yolk-granules' have disappeared and the egg envelope has separated from the vitellus, between which is the perivitelline space (breathing chamber).

Fig. 3.—Ovum 4 hours after fertilisation, showing the commencement of segmentation and the partial separation of the first two segmentation spheres.

Fig. 4.—Optical section of the four cell stage (9 hours). Only two cells are seen in section, and the first equatorial (horizontal) furrow is shown at *hf*[1], completing the bases of the first four segmentation spheres, and thus dividing the archiblast from the parablast.

Fig. 5.—Sixteen cell stage (11 hours), showing a portion of the protoplasm constituting the parablast as having left the germinal area and sunk to the yolk pole.

Fig. 6.—Slightly oblique view of a sixteen celled stage (13 hours), in which the commencement of a second horizontal furrow (*hf.*[2]) is seen.

Fig. 7.—Advanced segmentation stage (21 hours), showing a *morula* mass of cells in the archiblast, at a stage shortly prior to the formation of cells in the peripheral parablast.

Fig. 8.—An ovum 25 hours after fertilisation, showing the first row of cells in the peripheral parablast.

Fig. 9.—Part of an ovum shortly prior to the extension of the disc over the yolk (47 hours).

Fig. 10.—An ovum early on the 3rd day, showing the formation of the segmentation cavity and the germinal disc as it begins to extend over the yolk.

Fig. 11.—Stage a few hours later than that shown in fig. 10. The parablast is not indicated in this figure.

Fig. 12.—Still later stage (middle of the 3rd day), showing the mode in which the extension progresses.

Fig. 13.—Stage $3\frac{1}{4}$ days after fertilisation, showing the cap like blastoderm covering half the yolk. In the axis of the embryo the cells are several rows deep. There is a thickened rim at the margin, but more towards the centre the blastoderm is very thin.

Fig. 14.—Optical section in the direction of the longitudinal axis of the embryo ($4\frac{1}{4}$ days), showing the anterial portion of the thickened rims, which is pushed down over the yolk, and which later unites with the caudal extremity of the embryo, thus closing the blastopore. The dotted lines represent the thickened rim.

Fig. 15.—Optical longitudinal section of a 4½ days embryo, showing the blastopore shortly before closing.

Fig. 16.—Optical transverse section about the same stage.

Fig. 17.—Optical section of the longitudinal axis of an embryo at the end of the 4th day, showing the closure of the blastopore and the space between the cells in the thickened rim, which are derived from the archiblast and those supplied by the parablast.

Fig. 18.—Later stage not described in this paper but which is given here for reference.

Fig. 19.—Section of an unfertilised ovum stained with carmine. The yolk is unstained and the germinal protoplasm shows as a network between the yolk spheres.

Fig. 20.—Section of an ovum 4 hours after fertilisation, showing the collection of protoplasm into the germinal mound and the processes which are still left in communication with the yolk. The yolk spheres are not indicated in outline.

Fig. 21. Diagrammatic section of a blastoderm at the commencement of the pseudo-invagination process. The shading in the marginal rim shows the cells derived from the parablast.

Fig. 22.—Diagrammatic transverse section of a stage similar to that shown in fig. 12, showing the keel (axis of the embryo) and lateral prolongations of the blastoderm, which are thickened at the margin.

Fig. 23.—Diagram showing the formation of the primitive hypoblast from the parablast.

Fig. 24.—Section of an embryo (somewhat diagrammatic) about 4½ days old, showing the three primary germinal layers. In reality the blastopore is closed at this stage.

ARE HERRING OVA LIKELY TO DEVELOP NORMALLY ON THE DEEP OFFSHORE FISHING BANKS? By J. C. Ewart, M.D., Regius Professor of Natural History, University of Edinburgh, Member of the Fishery Board for Scotland.

Until comparatively recent years nearly all the herring taken in summer were captured by small boats within a few miles from the shore. In 1852, *e.g.*, immense herring shoals reached the Moray Firth to spawn on the Guillam and other inshore banks. Since 1852 the fishing boats have greatly increased in size, and owing to the introduction of cotton nets, each boat has added greatly to its catching power.

As the boats have increased in size and sea-worthiness, the fishermen have proceeded farther and farther to sea in search of the herring shoals, and now the greater number of the herring are taken from 40 to 60 miles from the coast. It is often alleged that it was owing to the herring deserting the inshore grounds that the fishermen proceeded to sea in search of the shoals, and also that it is because the fishermen disturb and break up the shoals early in the season that they no longer or seldom visit their old spawning grounds. There is no doubt that during the last fifteen years comparatively few herring have been captured during the summer over the inshore banks of the Moray Firth; but whether this is the result (as is alleged) of the fishermen intercepting and breaking up the shoals before they have had time to reach the inshore ground it is impossible to say. It is, however, a question of great interest, and one which could in all probability be easily settled. There is in Germany, Russia, Poland, and other continental states, a considerable demand for large full cured herring. For some years our curers have been attempting to meet this demand by sending large parcels of small fish with the milts and roes in many cases only partially developed.

One way of preventing the markets being flooded with small unripe herring would be to refrain from fishing in the various districts along the East Coast until the fish, large and small, had reached maturity. If this were done, even for one year, the problem above referred to would most likely be solved. In all probability the herring would be found as abundantly as in former years in the inshore waters, and the fish captured would be larger and riper than those taken early in the fishing season of 1884 and 1885 from the corresponding shoals.

That the takes during recent years have consisted chiefly of small fish (so-called maties), will be evident by a reference to Reports of the Fishery Board. In 1860 over 192,000 barrels of herring received the full crown brand, while only 171 barrels were branded as maties; in 1870 in round numbers 196,000 barrels received the full crown brand, and nearly 37,000 the matie brand; in 1875 the maties branded were more than half the full herring branded (156,000 barrels of maties to 281,000 barrels of full herring); in 1880 the full herring only outnumbered the maties by about 40 barrels; while in 1885 there were 300,000 barrels of maties branded and only 200,000 barrels of full herring. It is generally admitted that the great depression of the fishery industry which now prevails would, to a great extent, have been prevented if half of the small herring (the maties) had been left in the sea.

Many of those who account for fewer herring being captured inshore, by saying it is impossible for them to run the gauntlet of the thousands of nets that are night after night drifting across their path, assert that the eggs are incapable of developing in deep water, and that in course of time the offshore shoals will diminish or disappear. Of this there is in the meantime no evidence. As a matter of fact, for all we know there may have been immense shoals of herring spawning on the banks which lie at a distance of from 30 to 60 miles off the Scottish Coast for centuries.

The existence and continuance of offshore shoals will, to a great extent, depend on whether the herring are able to reproduce themselves without visiting the inshore spawning banks, and the success of the herring industry will depend on whether the herring shoals, which are invaded annually by our fishing fleet, continue to spawn sufficiently near the coast to render their capture a profitable enterprise for our fishermen.

Herring seem to exist in considerable numbers around the coast throughout the entire year, but in order to have a successful fishing, it is necessary to have large shoals moving about in limited areas. Such shoals are only found on the East Coast during the winter and summer spawning seasons.

If herring ova are capable of hatching in deep water (say from 60 to 100 fathoms), it may be taken for granted that almost any of the many gravel-coated banks of the North Sea may serve as spawning beds. The North Sea, as reference to a chart will show, is remarkably shallow. If soundings are taken from Kinnaird's Head to the Naze on the south of Norway, the greatest depth made until we are within some 30 miles of the Norwegian Coast is 70 fathoms. The 50 fathom line is about 100 miles from the coast between St Abb's Head and Montrose, and in order to get 50 fathoms water off Aberdeen we require to sail eastwards 50 miles. Between Peterhead and Orkney, however, the 50 fathom line lies from 20 to 30 miles from the coast. As a matter of fact, there is only one small area off the East Coast where a depth of 100 fathoms is reached. This area, generally known as the 'Pot,' lies from 2 to 5 miles off Fraserburgh; its greatest depth is 107 fathoms.

Having seen that the North Sea is, generally speaking, very shallow, let us now inquire as to whether herring eggs are capable of undergoing their development in water from 50 to 100 fathoms.

The most certain way of proving this would be to dredge herring spawn from one of the offshore banks in an advanced stage of development. I have made several unsuccessful attempts to do this while H.M.S. 'Jackal' was cruising some 40 miles north-east of Fraserburgh.

Instead of continuing the attempt to dredge spawn from deep water under unfavourable conditions, it occurred to me that it was possible to practically settle the question at issue by depositing eggs in deep water, so as to learn whether or not they would develop in the usual way. An attempt to do this was made in 1884, but without success. In the autumn of 1884 I was unable to join the 'Jackal' until the fishing season was nearly at an end. However, after some difficulty, ripe herring were obtained, and the artificially fertilised eggs deposited in the deep water off Fraserburgh in wooden boxes specially constructed for the purpose. Unfortunately a storm set in the day before it was arranged to haul up the boxes, and although diligent search was made in all directions in the vicinity of the 'Pot,' it was impossible to find any trace of either the buoys or the hatching boxes.

Owing to the Moray Firth being in many respects unsuitable for this experiment, I turned my attention to the West Coast, and found a comparatively sheltered spot in Loch Fyne, with a depth of 104 fathoms. To insure success, I had a small tank constructed of thick slate slabs firmly bound together by iron rods. The tank, though only about 20 inches square, weighed nearly 2 cwts. In the top and in two sides of this tank small windows were made about 6 inches square. Each window was carefully fitted with a teak frame, across which a single layer of horse-hair cloth was stretched. These windows admitted a sufficient current of water to pass through the tank. All the necessary preparations having been made for depositing the tank during last autumn, we were arranging to have eggs conveyed from the East Coast, when it was discovered that herring were spawning in Loch Fyne. Mr Brook, who was engaged at the Fishery Board Tarbert Station during the autumn, kindly undertook, in my absence, to obtain eggs and superintend the sinking of the tank in the 100 fathom water. Eggs were obtained on the 11th of September from herring caught in Kilbrannan Sound in water varying from 8 to 12 fathoms. All the eggs were placed at first in the laboratory in water, which had an average temperature of 54° Fahr. Most of the eggs kept in the laboratory hatched out on the 19th, while others only hatched on the 24th, thirteen days after fertilisation.

On the 16th, one of the glass plates, coated with eggs, was introduced into the tank above mentioned, which was immediately conveyed to the middle of the channel and deposited in 98 fathoms water, about three miles off Tarbert. The tank was lowered by means of a strong manilla rope, to the upper end of which a large cask was attached to serve as a buoy. The surface temperature was 54° Fahr., the bottom temperature was 49° Fahr. The bottom around the tank was chiefly composed of mud. On the 24th—*i.e.*, thirteen days after fertilisation, and eight days after the eggs were deposited in 98 fathoms water—the tank was raised. On examining the glass plate, it was found a number of the eggs in the centre had been destroyed by a fine coating of mud, which had entered through the hair-cloth screen, while those near the margins contained vigorous embryoes almost ready to hatch; in a few cases hatching had taken place. The average bottom temperature while the eggs were deposited was 49·3° Fahr.; the average surface temperature, 54° Fahr., the difference being 4·7°. This is a much smaller difference than was expected, and may be accounted for by warm bottom currents running along the deep narrow channel which extends from opposite Tarbert

towards Ardrishaig. The difference of 4·7° during the eight days which the eggs were deposited delayed hatching for about five days.

This experiment clearly shows that the only difference between the hatching of herring ova in deep and shallow water is one of time, hence we are safe in concluding that if herring deposit their eggs on suitable ground, in any depth of water not exceeding 100 fathoms, they will undergo development. It is conceivable, however, that the depth of the water in which the eggs are deposited may have some influence on the time of spawning—in other words, on the fishing season; and the immature condition of the fish caught in August during recent years may to some extent be accounted for in this way. If the herring which formerly spawned on the inshore banks of the Moray Firth in from 10 to 20 fathoms water now spawn offshore in from 40 to 60 fathoms water, the hatching will be delayed for several days, and maturity will not be reached as early as formerly. This is an argument in favour of beginning the herring fishing later in the season than at present.

But although it has been proved that herring ova are capable of hatching in deep water, it may be said that the fry would never succeed in finding their way to the surface; and further, that having reached the surface, the food so necessary for the early stages of their existence may not be found forty to sixty miles from shore. First, as to their power of reaching the surface.

In a paper published in the Fishery Board Report for 1883, I mentioned that, 'as soon as the fry escaped, they began to ascend by a wriggling motion towards the surface of the water, rising at first only a few inches at a time, to turn and slowly sink head downwards towards the bottom. During the first day they seldom succeeded in rising more than two or three feet from the bottom, and this they only succeeded in accomplishing after many attempts; but on the second day they readily, almost without a single rest, rose three feet at a time; and on the fourth day they succeeded in swimming freely on the surface of the water.'

There can be little doubt as to the purpose of this strong instinct to reach the surface; it is to bring them to the strata of water in which there is the largest supply of food. When hatched, the fry have in their yolk-sac sufficient nourishment for several days—the number of days depending on the time required for hatching. Those who have seen the small, almost invisible, newly-hatched herring fry will naturally think 100 fathoms is a long way for them to travel before they reach their food supplies. If, however, the fry are kept under observation, it is found that, after the first day, they can ascend at the rate of a fathom per minute. At this rate they could ascend 100 fathoms in 1 hour 40 min. If we allow for a rest of 30 sec. every three feet for the ascent, we have another hour and 40 min. to add. Again, if we suppose they sink 30 inches during each rest, we increase the distance to be covered to 150 fathoms; in other words, we add 1 hour 40 min. to the time required, which gives a total of about 5 hours for the 100 fathoms. This being the case, we cannot suppose that the fry would have any difficulty in ascending 200 fathoms before the nourishment in the yolk-sac was exhausted.

We are not well acquainted yet with the food of the fry, but there is no doubt about the richness of the surface fauna beyond even the fifty-mile line. The surface fauna of the Moray Firth is extremely rich, and, as I have again and again proved, surface forms are nearly as abundant in the Moray Firth forty miles at sea as they are inshore.

My thanks are especially due to Mr Brook for undertaking the work in Loch Fyne, and to the master of the fish carrier 'Talisman,' the property of Mr Maclachlan, of the Glasgow fish market.

REPORT ON THE HERRING FISHERY OF LOCH FYNE AND THE ADJACENT DISTRICTS DURING 1885. By GEORGE BROOK, F.L.S.

WHILE superintending the erection of the Fishery Board's Laboratory at Tarbert in the spring of last year, I made extensive inquiries concerning the herring fishery of the district. I was soon led to the conclusion that the Loch Fyne fishery probably presents greater facilities for an investigation of the life history of the herring than are to be found at any other part of the coast of Scotland. The problem is a difficult one in any case, but the land-locked area of the Clyde estuary naturally offers greater advantages for such an inquiry than would be the case if the whole district were open to the Atlantic. Whenever fish proceed far out to sea, it becomes almost impossible to follow them from place to place. On the West Coast, between Inveraray and the south of Arran, the herring frequent a series of comparatively narrow lochs and sounds, in which their movements and migrations may be more easily followed. Again, the chief herring fishery seasons in Scotland are during the spawning period. Loch Fyne is however an exception in this respect. The fish resort there primarily for the purpose of feeding, and the majority of the herring leave Loch Fyne before the spawning season has arrived. The district thus offers special facilities for a study of the growth as well as the migrations of the herring.

Although my investigations have mainly been carried on in Loch Fyne and the Sound of Kilbrannan, I have been led to conclude that the fishery of the whole Clyde estuary must be studied as a whole, and that the herring fishery of each district is inseparably connected with that of neighbouring districts. For this reason I have included the whole of the waters north of a line drawn from the Mull of Kintyre to Loch Ryan, in what I have termed the *Loch Fyne area.* There are fishery officers stationed at Girvan, Campbeltown, Greenock, Rothesay, and Ardrishaig, and there is also an assistant officer at Tarbert. The herring fishery in these five districts may be separable, so far as statistics are concerned, but I hope to show that from a biological point of view it is necessary to consider the whole as comprising one area of migration.

I am indebted to the Board's officers in these districts for much valuable information concerning the herring fishery of the Clyde estuary during the present and past years. It is the general belief amongst the Loch Fyne fishermen that the herring which are caught there during the summer are to a large extent the same fish which spawned at Ballantrae in the spring. The spawning season at Ballantrae extends from the beginning of February to about the end of March. Last year the Ballantrae fish left the spawning ground about the 26th of March, and on the 31st of the same month about sixteen boxes of herring were caught off Campbeltown, which were regarded as Ballantrae fish. The herring are then supposed to pass along the Sound of Kilbrannan to Loch Fyne. The earliest catch in Loch Fyne was near Skipness Point about the 15th of April. These herring were mostly spent fish and in very bad condition. Throughout the remainder of April occasional takes of a similar kind were made, and in the beginning of May the fishing became general north of Skipness. The weather was unsettled in the Campbeltown district, and although boats went out occasionally during April, there was practically no fishing until May.

The Loch Fyne fish in April and early May are mostly about 9 to 10 inches long, and are in very bad condition. They are scarcely fit for food

when they enter the loch, some that I tasted being quite insipid. They have little commercial value, and sell for a few shillings a cran.

Growth of the Herring.

The herring improve rapidly in condition from the moment they enter Loch Fyne. They feed ravenously on the immense shoals of copepods which make their appearance in May. The commonest form is *Calanus finmarchicus*, a species which is common around the British Isles, but which in Loch Fyne constitutes almost the sole food of the herring at this season. This species appears to occur in Loch Fyne throughout the year, but is rare in the colder months. From January to March a few may be taken any calm day with the surface net. They are then quite transparent, and the arrangement of the viscera is easily seen through the carapace. In April they rapidly increase in number, and a few are seen to have a number of small reddish oil globules under the carapace. In May and June they occur in myriads. At this time immense floating masses are to be seen in calm weather, which give the sea quite a red tint. The copepod itself is really transparent. The colour is due to the large number of red oil globules above mentioned. One day in the month of June the tide left such immense numbers of this copepod on the beach in front of the Tarbert Laboratory that the ripples in the sand appeared to be filled with blood. In July the number of *Calani* decreases rapidly, and in August we again found transparent specimens, while in September the stock was reduced to that found in the beginning of the year. Whether the myriads of *Calani* are bred in Loch Fyne or enter it in the spring I have not determined. It is, however, a significant fact that the herring enter Loch Fyne as the crustacean becomes abundant, and begin to leave it again as the stock gets exhausted. There is no doubt that the movements of the herring are to a large extent dependent on those of the copepods on which they feed. This fact is well-known to the fishermen. The floating masses are easily affected by wind and tide, and according to the direction of the wind, the copepods (and therefore the herring) may be expected in certain quarters. This is, however, not an infallible guide, but it serves as a basis to work upon.

It has already been stated that the fish thrive well on such rich and abundant food. In the beginning of the season the herring average 10 inches in length; three months afterwards the average is 12 inches, and I have seen herring in August quite 15 inches long. There are evidently several broods or races of herring in Loch Fyne during the summer. In May the fish do not vary much from 10 inches in length, and the roe and milt is not developed. During the next two months two broods at any rate may be distinguished. The one does not increase much in length, but quickly improves in condition, and the roe and milt advance rapidly towards maturity. At the end of July the ova are nearly ripe, and the fish are short and thick compared with others. These spawn in August. The second brood is not distinguishable from the first in the early part of the season. As time goes on, however, these fish increase from 2 to 3 inches in length, and in August are immense fish, the finest I ever saw. During the period of rapid growth the development of the reproductive elements remains comparatively in abeyance. They are not ripe until the middle of September at the earliest, while the majority spawn in October.

I believe there are other races of herring in Loch Fyne besides the two named, but the subject is a difficult one and requires further study. I am, therefore, led to think that Loch Fyne is now a feeding area for the herring of the Ballantrae, Campbeltown, and other districts, and that the whole collection is a mixed one. As the copepods diminish in

quantity the herring have to seek other food. This, from the month of August, consists chiefly of schizopods, a group of shrimp-like crustacea. The chief food form is *Nyctiphanes norvegica*, but there is an admixture of *Boreophausia Raschii*, *Siriella*, and other forms. A more detailed account of the food of the herring in the Loch Fyne district will be found in the report devoted to that subject. One point is, however, worthy of note, namely, the marked contrast between the food on the East Coast and that on Loch Fyne.

On the East Coast most food is found in the herrings' stomachs during the winter and spring. The crustacean food is certainly the most important, and consist mainly of two species, *Hyperia galba* and *Nyctiphanes norvegica*. The copepods do not contribute an important part of the food. This is partly to be accounted for from the fact that when the copepods are most abundant—viz., in the summer—the fish take little or no food. In Loch Fyne *Hyperia galba* is certainly rare, and I have never met with it in the stomachs of herring from that district. The period of growth is there during the summer months, and the sole food worthy of consideration consists at that time of copepods. *Temora longicornis*, *Pseudocalanus*, *Dias*, and other genera are common, but these sink into insignificance when compared with the teeming myriads of *Calanus finmarchicus* which, during the summer, are so rich in brilliant red fat globules, that each shoal may be readily seen from a boat.

Quality of Loch Fyne Herring.

This difference in diet appears to me to account for the difference in quality of the herring from the two districts. The East Coast herring are mostly cured, and are admirably suited for the purpose, as they are not over-rich in fat. The Loch Fyne herring, on the other hand, are nearly all sold fresh. Their large size and rich flavour has obtained for them the highest place amongst fresh herring in the kingdom. The flesh is extremely oily, so much so, that in the summer months they are quite unfit for curing. This amount of fat gives the herring another character altogether. To be thoroughly appreciated they require to be eaten the day they are captured, and are like mackerel in this respect. [Incidentally it may be remarked that mackerel feed on the same forms as the herring in Loch Fyne. In both cases the oiliness is probably due to the food]. If the herring are not cooked until a day or two after they were captured their flavour is quite different. The fat in the meantime seems to turn somewhat rancid, and the whole delicacy is lost. The Loch Fyne fish are on this account so easily distinguished that many fishermen regard them as a distinct species, or more properly speaking, as a well defined race. The flavour of these fish, and to a great extent their size also, appears to be due to the rich supply of copepoda in Loch Fyne. Curing operations usually commence in September. The supply of copepods having practically ceased in August, the fish feed on schizopods and annelids. In the course of a month their flesh has lost so much of its oily nature that the fish are then suitable for salting.

Gut-Poke.

Almost all the herring in Loch Fyne are subject to a complaint known as the *gut-poke*. In the month of June the majority of the herring were in this condition. I am told, however, that the duration of the period during which gut-poke herring are captured in Loch Fyne varies in different seasons. The disease, if indeed it may be so called, appears to me to

be the result of over-feeding. When a gut-poke herring is examined a large amount of red oily matter may be seen to issue from the vent. This appears to consist almost entirely of the partly digested remains of copepods. The stomach being overtaxed, a large percentage of the oil contained in the *Calani* passes along the intestine undigested, and issues from the vent mixed with the chitinous shells and other disintegrated remains of the copepods.

When the fish are in this condition they are of little market value, as they will not keep at all. They are quite good to eat if cleaned at once, but after being kept some time putrefaction sets in, and the whole alimentary tract becomes blackened. The evil is only a temporary one, and if the fish are left to themselves they soon regain their normal condition. I see from the evidence given before the Royal Commission appointed to inquire into the herring fisheries in 1877 that many fishermen urged that gut-poke herring should not be taken, and that a bye-law should be passed to prohibit their capture. This would indeed be a useful measure, as if allowed to remain a few weeks the fish would sell for three or four times their value in the gut-poke condition. I fail, however, to see how it could be carried out. The gut-poke herring are so mixed up with those in a healthy condition that it is impossible to catch the one without the other. There appears therefore no remedy.

Spawning.

Loch Fyne has now lost its ancient reputation as a spawning ground. During the last twenty years scarcely any herring have spawned in Upper Loch Fyne. Prior to that period the waters north of Otter Spit were teeming with spawning herring in the month of October, the head of the loch having been a particularly favourite quarter. Hitherto I have not had an opportunity of examining these deserted spawning beds, but hope to report on them on a future occasion. In the lower portion of Loch Fyne, *i.e.*, from Ardrishaig to Skipness Point, a number of herring appear to spawn every season. So far as my investigations go, however, there does not appear to be any regular spawning bank such as is found at Ballantrae. I found a few herring ripe in various localities from the end of July, but ripe herring were not caught in the same locality night after night. About the middle of July a few ripe males were obtained off Laggan on several occasions. It was noted that there were more ripe fish when the take was small, and in the larger takes the ripe herring were usually meshed in the net. In the beginning of August a few ripe females were obtained in the same locality on three or four consecutive nights. From this time to the 12th of September no ripe females were obtained near shore between Tarbert and Skipness so far as I have been able to ascertain. On most occasions, however, a few males could be obtained which were either quite ripe or nearly so.

During the latter part of August, when no ripe females were obtained by the trawlers, it was a common thing for the drift-net men, who had been fishing in the centre and as far south as the Cock of Arran, to bring in *small* catches of herring containing a large percentage of ripe females. On many occasions the roe lay in heaps in the bottom of the boats. During August and the early part of September a few ripe herring were taken occasionally in the north bay at Barmore. Their occurrence was, however, very irregular. Full herring were also taken between Ardrishaig and Barmore by drift-nets in the latter part of August, and a few were secured in a similar manner near the east shore of Loch Fyne.

Without doubt the greatest numbers of full fish were found south of

Tarbert, but they were seldom met with in the same locality on two consecutive nights. It often happened that after a small haul of full fish a better catch of fish in good condition was secured at the same spot a few hours later. As we were desirous of securing some herring ova for observation in the Tarbert Laboratory, Mr Calderwood and I made frequent excursions among the fishing boats. Although we went out three or four nights a week during August we failed to secure both ripe males and females from the seine trawlers on the same evening. In September the ripe fish nearly all left the loch, and we had to seek them in the Sound of Kilbrannan. This is now an important spawning district, and there are several spots between Skipness and Campbeltown where, I am informed, the fish spawn regularly every season. Our investigations were only pushed so far south as Saddle Point, but I am informed by the Fishery officer at Campbeltown that there are several small spawning banks between Saddle and the Mull of Cantyre.

Full herring were caught off the point north of Sunidale Bay in August on several occasions, sometimes with the spawn running from them. The ground off Saddle Point is also a favourite spawning place in August and September. On the 11th of September Mr Calderwood obtained ripe fish from a pair of Tarbert skiffs, at the southern point of Cour Bay. The catch was small and the herring of medium size, but nearly all were ripe. A batch of eggs were artificially fertilised and transferred to the Tarbert Laboratory. A pair of Campbeltown skiffs reported that, when dredging with grapnels for a net lost a few days previously at this spot, they brought up large quantities of herring ova on the hooks of the grapnels. Mr Allan (Tarbert) tells me that at the end of October a crew obtained 60 boxes of spawning herring two miles south of Skipness Point in the evening. Next morning another crew secured a take of 200 boxes of fish in excellent condition on the same ground. Thus even outside Loch Fyne the herring seem more or less migratory during the spawning season, but there seems little doubt that the fish which become mature in Loch Fyne deposit their spawn between Skipness and Campbeltown. This occurs chiefly between August and the end of October. I am therefore led to conclude that just as the fishing has left the upper waters of Loch Fyne, so the spawn which under former conditions would have been shed in Loch Fyne proper, is now mostly deposited in the Sound of Kilbrannan.

The question next arises, 'Do the herring on the West Coast spawn twice a year?' From my study of the question up to the present I am led to believe they do, but it is difficult to bring forward conclusive proof. If the herring which spawn at Ballantrae in February and March, and those which spawn in the Campbeltown district in the spring, are really those which are found during the summer in Loch Fyne, there is little doubt in the matter. The fish which enter Loch Fyne in April, May, and June are either spent fish, or at any rate fish in which the milt and roe is scarcely developed. During their stay in the loch the milt and roe become matured, and the spawn is shed from August to the end of October, either in Loch Fyne itself or in the Sound of Kilbrannan. I hope to investigate this point more thoroughly another season. For the present it may be assumed that the Ballantrae fish spawn in February and March, and probably again in August and September, and that those belonging to the Campbeltown district spawn in spring and autumn. This, however, is only an assumption, and, in the absence of further evidence, can only be accepted provisionally.

Migration.

The probable course followed by the herring on their way from Ballantrae to Loch Fyne has been already indicated. It is, of course, possible that some of the shoals keep to the east of the Island of Arran and enter Loch Fyne by way of the Sound of Bute, but I have as yet no evidence in favour of this view. The general opinion amongst the fishermen and the locality in which the earlier captures are made seem to show conclusively that the majority of the fish traverse the Sound of Kilbrannan.

During the early part of May several large shoals of herring entered Loch Fyne, and before the end of the month the bulk of them had settled along the east side of the loch from Otter Spit to opposite Tarbert. For many years very few herring have been taken in Upper Loch Fyne. About the middle of June a large shoal of herring entered the upper loch this year, and for eight or ten days a good fishing was obtained between Minard and Otter Spit. The herring commenced to leave the shallow waters on the east side of Loch Fyne early in July, and by the end of the month the fishing north of Tarbert was brought to a close. As the fish begin to leave the neighbourhood of Otter Spit they congregate mainly near the west shore, between Tarbert and Skipness, and the fishing remains in that locality until the close of the season.

While in Loch Fyne the movements of the herring shoals are doubtless to a great extent dependent on the supply of food. It appears, however, that the fish do not usually follow their food about from place to place, but remain in certain districts for a considerable time. In some cases the same class of fish are found on the same ground year after year. Mr Allan tells me that for the last three seasons a shoal of large herring of superior quality has visited the vicinity of the North Yellow Island in the first week of July and left it again at the end of the month. It has also been noticed that the same class of herring make their appearance off Laggan towards the end of July in each year, and generally supply a good fishing.

In the majority of cases the various shoals seem to change their quarters frequently, and I have often been impressed by the marked contrast between the class of fish taken on the same ground at two consecutive hauls. Again, it is no uncommon thing two crews working within a few yards of each other to obtain entirely different classes of fish. In some cases there may be a difference of two inches in the average size of the herring in each haul, in others the contrast is one of quality. The same ground is often occupied by distinctly different shoals during certain parts of the day or night. It often happens that when a crew get a haul of small herrings in the evening, they obtain a take of fine large herring by working over the same ground again in the early morning.

The herring leave Loch Fyne gradually. During the past season the migration commenced about the 1st of August, and the shoals were then followed further and further down the Sound of Kilbrannan. Fishing north of Skipness practically ceased in September, but good hauls were made near the mouth of the loch until the middle of October. The last catch of herring in Loch Fyne was on the 1st of November. The fishing in the Sound of Kilbrannan extended until the end of October, and a large number of fish spawned during that and the previous month on the Cantyre shore. On leaving Loch Fyne there is no doubt that the whole of the herring do not return along the Sound of Kilbrannan. For the past three or four years a part at any rate have been found in the Sound of Bute. The Fishery Officer at Campbeltown (Mr Hendry) has supplied me with the following account of the movements of the herring in his district:—

The bulk of the fishing in the Sound of Kilbrannan is on the Cantyre coast. In the early part of the year, when a commencement is made on a small scale usually, the first attempt is a little south of the Island of Davaar, which lies at the mouth of the Campbeltown Loch (March 31st). As the season advances, the herring seem to move northwards, and in the best part of the season are found in largest quantities near the Isle of Ross (about seven or eight miles north of Campbeltown), about Carradale, in the vicinity of Cour, and close to Skipness Point. This year a very heavy fishing was secured near the Isle of Ross in the latter half of October, and the season then closed. The herring are thought to take to deep water, and no doubt ultimately pass the south of Arran on their way to the Ayrshire coast.

In the Rothesay district (which includes the island of Arran) there has been little fishing during recent years until the close of the Loch Fyne fishing. In the month of October one or two large shoals pass down the Sound of Bute on their way to the Ayrshire coast. Mr Skinner has given me the following account of the route taken by these fish. During the week ending 10th October there was an extensive fishing in Pirnmill Bay (Arran). The shoal on visiting this bay was cut up, and in the following week the fishermen again fell in with the herring off Sannox (Arran), and also off Garroch Head (Bute). For three or four weeks there was a general fishing by drift-net off Garroch Head. By the 14th November the same class of herring was caught in Port Crawford and Ardneil Bays on the Ayrshire coast. On leaving these bays the herring were next met with off Ardrossan. Up to the 28th November the herring were in good condition, and equal to those found in Loch Fyne. After that date the fish were thin and poor. The fishermen state that the fish of inferior quality were caught in shallow water, and were generally seen playing at the surface, and that the large and heavy fish had then taken to deeper water.

The whole of this evidence appears to show that besides a small supply of local herring—what the fishermen term 'ground keepers'—there are probably at least two migratory races of herring in the Clyde Estuary. The one spawns off Ballantrae in February and March, and the other in the Campbeltown district in May. It is probable that both these races reach Loch Fyne in the summer. Nevertheless, the upper portion of the Sound of Kilbrannan is almost as rich a feeding ground as Loch Fyne itself, and it is difficult to say whether certain fish do or do not pass Skipness Point. In the autumn the various shoals on leaving Loch Fyne divide at the Cock of Arran. The majority pass down the Sound of Kilbrannan, the remainder follow along the Sound of Bute, and reach the Ayrshire Coast in November.

On both sides the fish are reported to take to deep water before the end of November, and are then lost sight of. I am not inclined to think that the smaller fish caught off the Ayrshire coast (Ardrossan) in the winter are those which visited Loch Fyne in the summer. Where these fish come from or whether they form part of the fish which spawn at Ballantrae a few months later I am not at present in a position to say.

The fishing commenced earlier than usual during the past season, and also closed before the usual time. In 1882 fishing commenced about 1st June, and continued until about the middle of December, October being the best fished month. The fishing of 1883 commenced and finished about the usual time, viz., June and October. The fishing of 1884 commenced about the 1st of May and closed about the end of August. During the past season the drift-net fishing was a complete failure, and very few boats went out; nearly the whole of the fish were landed by trawlers.

Statistics.

In the following tables I have given the weekly returns of herring captured in the Inveraray, Campbeltown, and Rothesay districts, for which I am indebted to the Fishery Officers. The returns show the migration of the herring from one district to another very well. I have also obtained from the officers at Ardrishaig and Campbeltown a return of the herrings caught in each district during the past twenty years. These are placed side by side, and it is interesting to note the gradual development of the fishing in the Campbeltown district—a development which one cannot help associating with the loss of the fishery in Upper Loch Fyne:—

TABLE I.—WEEKLY RETURN OF THE HERRING FISHING IN LOCHFYNE—SEASON 1885.

Date.	Crans.	REMARKS.
Week ending May 9	67	Weather favourable for fishing, reports of several shoals of herrings having entered Loch Fyne.
,, 16	486	Weather favourable for fishing, good appearance of herrings in Loch Fyne.
,, 23	560	Do. do. do. do.
,, 30	934	Nearly all the herrings caught on the east side of the loch during day time.
June 6	2667	Weather fine, fishing regularly prosecuted, chiefly between Tarbert and Ardrishaig on east side of loch.
,, 13	2744	Weather fine, fishing regularly prosecuted, chiefly between Tarbert and Ardrishaig, and during day time.
,, 20	2861	Weather unsettled, nothing done on two days of the week.
,, 27	2648	Weather fine, highest take 750 boxes = 338 crans, realised about £500.
July 4	1974	Weather unsettled, fishing interrupted on two days of the week.
,, 11	1764	Weather favourable, nearly all the herrings caught during day time up to this date.
,, 18	1749	Do. do. do. do.
,, 25	1399	Fishing light on the east side of the loch, herrings appear to be leaving east side.
Aug. 1	463	Fishing light between Tarbert and Ardrishaig, most of the herrings caught near Skipness.
,, 8	544	Fishing regularly prosecuted, herrings caught about entrance to loch.
,, 15	436	Do. do. do. do.
,, 22	960	Do. do. do. do.
,, 29	666	Do. do. do. do.
Sept. 5	434	Herrings caught about entrance to loch, most of the boats fishing in Campbeltown district.
,, 12	741	Do. do. do. do.
,, 19	564	Weather unsettled, fishing indifferently prosecuted.
,, 26	...	Weather unsettled. Bright moon light. No fishing.
Oct. 3	402	Herrings caught about the entrance to the loch, weather unsettled.
, 10	1060	Heavy fishing about the entrance to loch, and in Sound of Kilbrannan. One Ardrishaig crew had a take of over 700 boxes accounted for in Campbeltown district.
,, 17	244	Fish caught about the entrance to loch.
,, 24	9	Weather favourable for fishing, but no fish.
,, 31	3	Weather favourable for fishing, but no herrings to be found in Loch Fyne.
Total	26,379	The takes obtained during season ranged from 10 to 200 boxes, and occasionally higher.

WM. JEFFREY, *Fishery Officer.*

Table II.—CAMPBELTOWN DISTRICT—Weekly Statement of Herrings Caught in the Campbeltown District—Year 1885.

Date.	Crans.	Remarks.
From Mar. 31 to May 31, 1885, bulk of catch in May	2363	In May the weather was favourable. Catch began about Campbeltown in pretty good quantity; as the month advanced the takes were secured further up the sound till Carradale became the chief centre.
Week ending June 6	109	Weather fine, catch mostly in mid-channel between Campbeltown and south of Arran, fishing at night.
,, 13	955	Weather very fine. Catch by drift nets in channel from off Saddell to off Davaar, 6 and 8 miles southwards, fishing at night.
,, 20	787	Weather generally fine, similar to previous week, fishing at night.
,, 27	677	Weather very fine. Best catch off Davaar, 6 to 8 miles south, also in mid-channel south of Kilbrannan, fishing at night.
July 4	1307	Weather fine, catch best off Davaar, south and mid-channel off Saddell, fishing at night.
,, 11	1263	Weather generally rough, heavy rain. Drift best takes off Davaar, and fishing by trawl in the vicinity of Carradale night and day.
,, 18	2421	Weather very fine, fishing by trawl night and day. Best takes about Carradale drift, off Davaar S.S.E.
,, 25	1886	Weather very fine, best takes south Ripness and Saddell Bay, also Pirnmill and near Pladda, Cantyre coast. Herrings excellent and large size, 250 filling a box. Fishing night and day.
Aug. 1	962	Weather extremely fine, fishing ground same as previous week.
,, 8	1349	Weather fine, fishing ground again in the same locality.
,, 15	1793	Weather stormy. Best near Carradale and off entrance to Campbeltown Loch, S.E.
,, 22	2348	Weather fine, catch heavy about Carradale, chiefly by trawl net, fishing by day.
,, 29	789	Weather middling, best near Carradale, fishing by day, and off Davaar, S.E., in mid-channel, fishing at night.
Sept. 5	1583	Weather fair, best takes about South Ripness and Isle of Ross. Fishing by day and night.
,, 12	2428	Weather stormy at Carradale, boats able to pursue regularly and had heavy takes. Trawl fishing by day.
,, 19	4790	Weather fair, best at Carradale, Cour, and South Ripness, Campbeltown now becoming light. Fishing by daylight chiefly.
,, 26	121	Weather stormy, no trial at Campbeltown, only once at Carradale. Fishing by day.
Oct. 3	2930	Weather fair, all caught near Carradale. Fishing by day, also about Machry Bay.
,, 10	4764	Weather squally, the herrings got near Isle of Ross.
,, 17	250	Weather unsettled, catch about Isle of Ross and about Carradale.
,, 24	967	Weather of a favourable kind, catch about Isle of Ross and near Carradale. Fishing by day and night.

ROBERT HENDRY, *Fishery Officer.*

Table III.—ROTHESAY DISTRICT.

Week ended.	Boats Fishing.	Crans Landed.	Remarks.
June 27	140	190	Caught off Loch Ranza and Pirnmill.
July 4	148	250	Caught on the Cantyre coast, Kilbrannan Sound.
,, 11	120	170	A great mixture of small herrings this week. Fish caught about Bute shores.
,, 18	63	77	Only a few herrings caught off Skipness. The best takes were got at the head of Loch Long.
,, 25	82	109	Caught off Loch Ranza.
Aug. 1	84	143	The principal fishing ground this week was off the north end of Arran.
,, 8	58	62	Weather in the Sound unsettled. Principal fishing ground in Loch Striven.
,, 15	56	82	Fish caught off Skipness and Sannox, Arran.
,, 22	78	200	Fishing carried on off Skipness and Sannox, Arran.
,, 29	20	34	Fish caught off Skipness Point. Weather stormy.
Sept. 5	151	284	Fish caught off Sannox, Arran.
,, 12	103	198	Fish caught between Skipness Point and Sannox.
,, 19	34	50	Caught off Sannox, Arran.
,, 26	54	130	Quality middling. Caught off St Ninians and Kilchattan Bay, Bute.
Oct. 3	60	45	Quality fair. Caught off Skipness Point.
,, 10	130	1954	Quality excellent. Caught in Pirnmill Bay, Arran.
,, 17	165	240	Quality excellent. During the week the fishing was prosecuted at two different places—off Garroch Head, Bute, and Sannox, Arran.
,, 24	185	574	The takes were mixed with light herring. Caught off Garroch Head, Bute.
,, 31	105	275	The takes mixed with light herring. Caught off Garroch Head.
Nov. 7	80	140	Quality good. Caught off Garroch Head.
,, 14	75	206	Quality good. Caught in Port Crawford and Ardneil Bays, Ayrshire coast.
,, 21	80	140	Quality good. Caught in Port Crawford and Ardneil Bays.
,, 28	50	72	Quality good. Caught in Port Crawford and Ardneil Bays.
Dec. 5	7	4	Weather stormy. Only one boat landed herrings.
,, 12	100	190	Quality not good ; fish very thin. Caught between the Cumbrae Islands and the Ayrsire Coast.
,, 19	78	147	Quality poor, and fish small in size. Caught 3 miles off Garroch Head.
,, 26	24	135	Quality poor, and fish small. The herrings landed this week were caught off the Ayrshire coast.

JOHN SKINNER, *Fishery Officer.*

Table IV.—Showing the result of the Herring Fishing in Loch Fyne and in the Sound of Kilbrannan for the past 20 years.

Year.	Total number of Crans. Loch Fyne.	Kilbrannan Sound.
1866	27,196	2,399
1867	36,697	3,720
1868	43,356	1,731
1869	39,214	5,943
1870	21,510	6,396
1871	29,452	5,711
1872	10,392	6,536
1873	10,272	16,613
1874	7,135	18,712
1875	14,355	6,427
1876	31,183	11,411
1877	23,332	18,298
1878	13,800	18,404

TABLE IV.—*continued.*

Year.	Total number of Crans. Loch Fyne.	Kilbrannan Sound.
1879	33,837	36,947
1880	30,193	44,788
1881	40,019	23,943
1882	84,854	53,505
1883	51,494	49,089
1884	21,515	40,953
1885	26,379	44,791
	Average.	
1866–70	33,595	4,038
1871–75	14,321	10,800
1876–80	26,469	25,970
1881–85	44,852	42,456

Influence of the Ballantrae Fishing.

For many years past there has been a great outcry against the Ballantrae fishing, on the ground that it proves injurious to the Loch Fyne fishery. The idea prevalent among the fishermen is that the capture of so many spawning fish robs the upper waters of their natural supply of young fish, Ballantrae being regarded as the spawning ground of the Loch Fyne herring. The question was reported upon by the Royal Commission on Herring Fisheries in 1879. The Commissioners held that it would be unjust to stop the Ballantrae fishing merely because the fish were spawning, and pointed out that if it were made illegal to catch full herring, there would practically be an end to the herring industry in Scotland. I am not, however, sure that the Ballantrae case is not a special one. On the East Coast the North Sea is a storehouse for herring. Usually when the fish come inshore it is for the purpose of spawning. If they were not caught then there is every probability that they would not be caught at all. In the Clyde estuary it is probable that the supply of herring is to a large extent dependent on the spawning which is carried on at Ballantrae and in the Sound of Kilbrannan. If it should prove to be the case that the herring of this district migrate backwards and forwards between Ballantrae and Loch Fyne, it is clear, I think, that the stock is liable to be diminished by a continuance of the Ballantrae fishing. Such a restricted migration has certainly not been proved as yet, though the observations brought forward in the present report tend in that direction. There is, however, little doubt that there are other sources from which the Loch Fyne herring fishery is kept up besides those already mentioned. Even granting that the fish which spawn at Ballantrae follow the course which I have indicated, there is one point which still requires elucidation. The fish on leaving Loch Fyne average 12 inches in length. Such large herring ought to be easily traced, yet after the month of November we have no account of them. They cannot spawn again at Ballantrae, for the herring there are not nearly so large. There is another factor in the question which requires consideration. It may be that a large number of the herring which spawn at Ballantrae are young fish which were originally hatched there, and which have been matured in Loch Fyne. There is no doubt that there are immense shoals of immature herring in Loch Fyne, particularly in the winter time, and it is equally true that many of the spawning herring at Ballantrae are very small fish, which probably have not spawned before. In this case the Ballantrae fishery would no doubt be injurious to the fishery of the district as a whole. The whole question, however, turns on the extent to which the fishery of the Loch Fyne district is kept

up by fish from the open sea. In the absence of information on this point it would be obviously unjust to make any distinction between spawning fish on the East and on the West Coast.

Enemies of the Herring.

In the report of the Royal Commission already referred to, great stress is laid on the immense destruction of herring by cod and gannets. A calculation is entered into to show that the destruction of herring by man is an insignificant item compared with the enormous number taken as food by cod and other fishes, and by predaceous sea birds, such as the gannet. This calculation is based on the assumption that gannets feed on herring all the year round, and that cod take them for seven months out of the twelve. I do not wish to under-estimate the immense destruction of herring brought about in this manner, but it appears to me that this assumption is not justified. I am not acquainted with any statistics which would lead one to suppose that the cod around our coasts consume anything like the quantity of herring indicated in the report. I may here refer to a paper on the food of the cod which I have contributed to the present report. The statistics there given are the result of the examination of about 300 cods' stomachs, chiefly from the East Coast. Judging solely from those statistics, it appears that the principal destruction of herring by the cod occurs in our inshore waters during the spawning season only. The fishery officer at Anstruther informs me that although herring are abundant on the distant cod fishing ground in the North Sea during the spring and summer seasons, it is seldom that any herring are to be found in the cods' stomach. On the other hand, when the herring come inshore to spawn, the cod and other Gadidæ cause an immense destruction amongst them. The case is somewhat similar at Ballantrae, as a reference to the evidence given by Mr Wilson will show.

Perhaps the herring, while in Loch Fyne, suffer less from the attacks of the cod and predaceous birds than in most other districts. There are not many cod in Loch Fyne, and the fishermen only follow this industry when not engaged in the herring fishery.

At Ailsa Craig there are thousands of gannets, and they undoubtedly cause a very great destruction of herring during the Ballantrae fishery. This, however, only lasts two or three months, and the herring then leave the district. The gannets do not follow the herring to Loch Fyne, or at any rate only very few do so. A few gannets may be seen any day in Loch Fyne during the herring fishery, but I have never seen thousands or even hundreds in a day. The few there are appear rather valuable than detrimental to the fishery. These birds prove useful to the fishermen in indicating the exact spot at which herring are to be found. It is only when the number of gannets is excessive that the destruction of fish which they cause comes to be a loss to the fishery. I conclude, therefore, that so far as Loch Fyne is concerned, the cod and the gannet are not responsible for a very large destruction of herring. The destruction is certainly not so great as occurs in many other districts. This, however, does not alter the fact that gannets are responsible for an enormous destruction of herring at certain spots around our coast, and the stock of these birds might certainly be diminished with advantage.

Day-light Fishing.

For many years it has been the custom in Loch Fyne to use the seine nets (trawls) in the day-time during a part of the season. I am told that this has never happened to so great an extent as during the past season.

The herring were nearly all caught in the day-time in the early part of the season, and the practice was not entirely discontinued until late in July. As a matter of fact, the fishermen continue the daylight fishing until the shoals of herring have become so disturbed and broken up that the fish can no longer be caught in the day-time. This practice is undoubtedly injurious to the fishery, and no one knows this better than the fishermen themselves. Every one admits the fact, and the majority of the fishermen in Loch Fyne are anxious that daylight fishing should be made illegal. Still they continue the same injurious practice year after year. It appears that so long as one man fishes in the day-time all must follow, if only in self-defence. Personal comfort is doubtless also an important factor in the case.

Weekly Close Time.

Another object for which the Loch Fyne fishermen have agitated for some years is that of a weekly close time. It is proposed that it should be made illegal to catch herring in their district from sunrise on Saturday until sunset on Monday. Sunday fishing is already illegal, though it is still practised by a small minority of the fishermen who do not belong to the district. It has been argued that such a regulation would be unfair to those who come from a distance, and who do not go home at the end of each week. I fail to see any unfairness in it, and some of the fishermen prefer to return to their homes in the middle of the week, so that they may return in time to make the earliest catches on Monday morning. I am convinced that such a regulation would have a salutary effect both on the supply of fish and on the duration of the fishery. Loch Fyne is a rather narrow loch, and with the hundreds of boats fishing week in and week out, the shoals of fish never get any rest. Questions of this kind appear to me to be simply matters of local government. If an overwhelming majority of the Loch Fyne fishermen are in favour of such a regulation, I see no reason why they should not have their wish. Bye-laws affecting this question, and also that of daylight fishing, need not necessarily apply to the whole country, and there is no doubt that such regulations are more required on the South-west Coast than elsewhere.

The Loch Fyne fishermen have also agitated for some time that it should be illegal to catch herring on the West Coast from 1st February to 1st May. Such a regulation would doubtless be chiefly directed against the Ballantrae fishing. I am not yet convinced that the Ballantrae fishing is so injurious as to demand legislative interference, and therefore cannot support the fishermen on this point without further evidence. There is, however, no doubt in my mind that the early fishing in Loch Fyne itself is not desirable. When the fish arrive in Loch Fyne they are in very poor condition, and have little market value unless supplies from other quarters are far short of the demand. If the fish were left alone for a month, I am convinced it would be better for every one concerned. In any case, the fish do not leave the district for many months, and by the end of May they would be in good condition, and sell for a better price. The chief end to be gained by such a regulation appears to me to be that the herring may, while unmolested, have an opportunity of reaching the upper waters. The upper portion of Loch Fyne is better suited for a spawning ground than the lower part, and if the herring can once be induced to spawn there again there would be every probability that the fish would not begin to leave Loch Fyne until late in October. The upper waters are, however, too narrow to admit of a large fleet of boats working at one time, and it is possible that if large shoals reached there they might quickly be driven out again.

Loss of the Upper Loch Fyne Fishery.

How far the loss of the Upper Loch Fyne fishery is attributable to the agency of man I cannot say, but it seems probable that at present there are several agencies at work, the removal of which would give the fish a better chance of returning to their old haunts. The chief of these are—

1. Great increase in the number of boats, and the introduction of a more profitable mode of fishing.
2. Daylight fishing.
3. Early fishing, before the fish have had time to settle down.

The first, of course, comes with the development of the fishery, and is unavoidable. If, however, our chief aim is to induce the herring to remain and spawn in Upper Loch Fyne, there is no doubt that trawling should be stopped in those waters simply because it is a more deadly method of fishing, and if practised in the daylight could not fail to ultimately drive any shoal of herring from such narrow waters. Nevertheless, I question whether the end justifies the means. Since the Upper Loch Fyne fishery ceased, that in the Sound of Kilbrannan has more than made up for the loss, and it is not to be expected that the fishing can be in both places at once.

Fishery Police and Statistics.

Perhaps I may be permitted here to call attention to one or two matters in connection with the Fishery Police and the collection of statistics by the Board officers, which appear to me to require readjustment.

In the first place, H.M.'s cutter 'Daisy' is entirely unfit for the duties she has to perform. No sailing vessel can be competent to superintend the herring fishery from Inveraray to Campbeltown. It very often happens that although there is urgent need of the services of the 'Daisy' for police or other duties, she is at the time becalmed, and thus her services are unavailable. It is very desirable that the 'Daisy' should be replaced at once by a small steam vessel, which could easily command the whole Clyde estuary. It would be a great boon to the fishing industry if a vessel of this class were kept continually between Ballantrae and Inveraray. At one place or another between these two points herring are being caught all the year round. The vessel should follow the fishing from place to place, and in this way much valuable information might be collected which could not be obtained in any other manner. In connection with this subject it seems a pity that one of the Board's officers should not have charge of the whole district so far as the herring industry is concerned. I am convinced that if any reliable information is to be obtained, this can be better accomplished by one officer who has instructions to follow the fish from place to place than by several officers each stationed at one centre.

During a great part of the Loch Fyne fishing there is not a single Fishing officer in the district. As soon as the great East Coast herring fishery commences, all the Board's officers are required to superintend that work, and the collection of statistics in Loch Fyne has to be left to correspondents. The collection of statistics of herrings sold fresh is admittedly more difficult than in the case of those which are cured, and this fact makes it all the more necessary that one officer should be left in charge of the Loch Fyne fishing. I may also call attention to the fact that the Loch Fyne herring are accounted for in the Board's statistics as being cured, whereas nearly all of them are sent to the market fresh. A number of swift steamers are employed for the purpose, and the fish are taken on board from the skiffs as soon as they have been caught. The same remark is equally applicable to the herring caught in the Girvan, Campbeltown, and Rothesay districts. Indeed the greater part of the herring

caught in the whole of the area covered by this Report are sold fresh. The quantity of herring which are salted or cured does not appear to be very great at any time, but varies at different seasons.

There is another point relative to the collection of statistics which is worthy of note. As at present arranged, the west shore of the Sound of Kilbrannan is in the Campbeltown district, while the east shore is in the Rothesay district. It is practically impossible to decide in many cases on which side the fish were caught, and it would be much more satisfactory if both shores of the Sound were under the charge of one officer. The whole of these considerations point to the necessity for the appointment of an officer who should be solely responsible for the statistics of herring caught between Ballantrae, Campbeltown, and Loch Fyne, and whose duty it would be to follow the fishing from place to place and make a thorough study of the whole industry. Such an officer would certainly require a more liberal allowance for expenses than is permitted under the present system, but he would do the work which now requires five men, and would do it better than is possible under the present conditions.

I cannot close this report without acknowledging my indebtedness to the fishermen and others connected with the fishing industry between Loch Fyne and Campbeltown, who have rendered me every assistance in their power, and who take a lively interest in the scientific investigations which are being carried on under the direction of the Fishery Board.

APPENDIX F.—No. IV.

REPORT as to VARIETY among the HERRINGS of the SCOTTISH COASTS. PART I. By J. DUNCAN MATTHEWS, F.R.S.E.

ALTHOUGH the herring, principally from its great commercial importance, has formed the subject of probably more investigation, and of a consequent literature both popular and scientific, than any other sea fish, the too general manner in which most of these investigations have been conducted has led to the most contradictory results, and very little to the real advance of our knowledge of the natural history of the fish itself.

So far as regards the elucidation of that part of the subject with which I am just now principally concerned, viz., the extent, if any, to which variety, individually or racially, obtains among the herrings of our coasts, past inquiries have failed to give satisfactory results, not only from the difficulty of procuring information on the subject, but because the observations have been made on far too limited a scale, and without proper comparison of the fish found at different times and in different localities.

The difficulties surrounding the subject still remain to interfere with a satisfactory conclusion being come to, but in this investigation the attempt has been made to reduce the error from limitation of observation to a minimum, by the examination of comparatively a large number of examples from various places and during all seasons.

The one real exception, so far as I am aware, to these remarks on insufficient observation, is that of Dr Heincke, who has made an elaborate investigation into the varieties of the herring of the Baltic, including a few from the North Sea (Peterhead and Norway), and whose results appear in an excellent report published by the German Fishery Commission.*

* *Jahrsbericht der Com. z. Wissensch. Untersuch. der deutschen Meere,* 1878, 1882.

As the plan which I have adopted for carrying out a similar investigation into the herring of the Scottish coasts differs in some of its details from Dr Heincke's, it must be explained that I had not read his paper until my own observations were almost completed, otherwise I would have taken measures for more readily comparing my results with his in detail, although I still prefer my own method as being in some slight respects more exact. The amount of labour involved in revising the work in detail for this purpose is, however, so great, that meantime it must be delayed, and where I have been able to make comparisons, it has mostly been with the concluding summary in Dr Heincke's paper.* The experience gained in measuring the first few fish received for the purpose of the investigation, was sufficient to show that a general preliminary examination of the results likely to be procured was necessary, in order to ascertain the best way in which these could be obtained. As the result of such an examination, it was early found that fish of the same length, and as nearly as possible of the same bulk, differed as to their dorsal and anal fins, not only in the position of these relatively to the length of body, but that the fins themselves varied both as to the length of their bases, and also in respect to the relative length of the individual rays, measured from their bases to their tips; a circumstance due not only to the different amount of wear they had undergone, which is probably slight, but also to absolute difference in the amount of their development, increased, as it likely is, by the difference in age of the fish. This led to an examination of the tail to ascertain whether the caudal fin was subject to similar variations, which might reduce the value of the total length of the fish as a basis for comparison of the other characteristics. In several cases it was clear that the length of the caudal fin was affected by wear, or by injury received after the capture of the herring. But a far greater difference was found in the actual length of the caudal fin rays as measured from their proximal ends, and also from the termination of the intervening and supporting hypural bones, in herrings as nearly alike as possible in the length and bulk of their bodies.

It was evident also that the fish (which were in all cases perfectly fresh when measured), were subject to very considerable variation in the position of the lobes of the caudal fin, caused apparently by the amount of muscular contraction after death, and, as a consequence of this, there of course resulted a considerable degree of variation in the total length of the fish (sometimes as much as 10 mm.), according to whether the lobes were approximated so as to be in nearly a straight line behind the body, or were widely spread.

For the purpose of comparison by measurement of those characteristics which were suited for being thus dealt with, any standard would be suitable, so long as it was not itself liable to much variation; and I resolved, therefore, to dispense with the employment of the total length including the caudal fin, as a basis, as being too likely, from the variation in length of the fin, to detract from the value of the results. Note was, however, taken of the length of the caudal fin, with the view of testing its variability correctly. The result was, that the length from tip of closed lower jaw to a point near base of caudal fin was fixed on as the most reliable, all that was necessary being that that point should be an easily ascertainable position. Probably the termination of the vertebral column would be the best 'total length,' but the additional work involved in ex-

* The amount of almost 'drudgery' entailed in an investigation of this nature is scarcely realisable by those who have not undertaken it. In my own case the mechanical work entailed amounted to the taking of about 16,000 measurements on the herrings, with over 20,000 subsequent calculations.

posing the vertebral column for this purpose, in a large number of fish, made it prohibitory. A modification was therefore adopted, and a point chosen, which was almost, if not altogether, of equal fixity with the end of the vertebral column.

Though the length of the bony support (hypural bones) of the caudal fin rays is not invariably of the same size in equal-sized fish, it is subject to fewer variations, and these variations, from the shortness of the total (about 10 mm.), are of very small amount. Now, as it is close to this that the silvery sub-epidermic layer covering the body terminates, thispoint—the few scales, if present, being scraped off—forms a well-marked one for the position usually called the base of the caudal fin, though it does not actually correspond to that position, and the whole length from the tip of the closed lower jaw to this point was therefore generally used as the standard by which the other measurements were to be compared. This is one of those minor details in which I have differed from Heincke, who employs the total length including caudal fin, but which has not a serious effect on the result, except in so far as it affects comparison of details. Then the exact fixture of the point which I have described does away with Heincke's objection to the indefiniteness of the terms 'without caudal fin' or 'base of caudal fin.' The fish on arrival were placed on a sheet of paper in such a position that a straight line would run through the tip of the closed lower jaw and the fork of the tail. A pencil was carried round the fish, so that a rough but fairly accurate life-size sketch was formed of it, useful in the event of its being afterwards necessary to have a general idea of its size and shape. The following points were then accurately marked off, and the measurements of length of head, positions of fins, &c., made along the longitudinal central line to perpendiculars drawn to it from the various points, except in the case of length of base of fin, the measurements of which were made along the actual fin :—

1. Anterior end of mandible.
2. Anterior end of premaxilla.
3. Centre of eye.
4. Back of head (of supraoccipital bone, which has an almost straight posterior border) ; this forms a much better standard of length of head than the length of the *side* of the head, which includes the opercular bone—liable to considerable alteration in position from various causes.
5. Base of anterior ray of dorsal fin.
6. Base of posterior ray of dorsal fin.
7. Termination of tail (as described above).
8. Tip of caudal fin.
9. Base of posterior ray of anal fin.
10. Base of anterior ray of anal fin. (This point has nearly always the same relative position with regard to the vent, any difference being more apparent than real, occurring especially during the spawning season from the enlarged and tumid condition of the latter, and from its contracted state in the spent condition.)
11. Base of first ray of pelvic fin.
12. Base of first ray of pectoral fin.
13. End of branchiostegal membrane.
14. Articulation of lower jaw.

Notes were also kept of the number of rays in the five fins, of the condition of the reproductive organs, of the date and place of capture, and, in several instances, of the number of keeled scales. The whole of the measurements were taken in millimetres.

For the purpose of comparison it was necessary that the whole of the measurements thus procured should be reduced to a ratio of some common

standard. As stated above, the standard generally adopted (I shall have to refer later to some necessary departures from this rule) was that of the length from the anterior end of the lower jaw to the base of the caudal fin; and to avoid confusion, this has been called length to end of scales, as distinguishing it from length to tip of tail. The means by which is indicated the position of the fins, length of head, &c., in works treating of fish, has varied generally in two directions. Either the dimension is stated as a part of the total length, *i.e.*, employing the total length as the unit, or the dimension itself is employed as the unit. Thus, for instance, the length of head of a 270 mm. herring would be described as being (say) ·133 of the total length (or, roughly, it would probably be stated as $\frac{1}{8}$), or it would be described as being contained in the body 7·5 times; the former result, of course, being found by dividing the particular dimension by the total length, the latter by dividing the length by the dimension. The common way appears to have been to obtain the latter result as a whole number only, and turn it upside down, so as to form a fraction of the body length. This latter is convenient, and for general purposes useful enough; but when comparisons of what may be rather minute differences, and where considerable exactitude are required, it may lead to important errors. For as the dimension descriptive of any character decreases in amount, the apparent variation by this scale becomes greater and greater; I shall have to refer to some of these effects later on. Professor Heincke in his paper has noted this error, and has, in dealing with such a small figure as the length of fins, changed his index of comparison, and calculated according to the proportion—Total length : 1000 : : Length of fin : x (the index); but he has not employed this method for finding the head index—a dimension of about the same magnitude. There is, however, such a difficulty in comparing the amounts of variation even where large dimensions are dealt with, such as the distance of dorsal and anal fins from tip of jaw, that for that reason, as well as for uniformity, I have adopted the more correct method throughout; my equation, however, reading—Total length : 1 : : The dimension : x, so that in place of getting a whole number, as Heincke does, I get that decimal fraction which at once conveys to the reader the proportion which the dimension bears to the whole length.

The various characters of the fish and their variations having been thus reduced to a regular standard for comparison, the method in which this is to be made has to be considered. In this preliminary paper I have treated dimensions, variations, &c., which were found to exist on the fish sent from the various Fishery districts in a more general manner than is essential, if we wish to reach a fairly dependable conclusion as to whether these variations are merely individual, or may fairly be called those of 'race' or 'variety.' I shall try to indicate the general characteristics and their variations which are to be found among our herring, the presence or absence of any one or more of these if fairly evident among the herring of particular seasons or localities, and generally the extent of the actual variation and the prevalence of any degree thereof. I leave for further investigation the more intricate work of ascertaining to what extent particular or generally localised variations may be found among those fish to which they are not peculiar, and what combinations of the several characteristics, as subdivided by their variations, may be common to all the herring, or any part of them.

General Size.

It may here be stated that the herrings subjected to examination were samples of the ordinary takes of the fishermen at various places around the

Scottish Coast during the winter and spring months of 1884 and 1885, and the summer months of 1885. They were procured and forwarded while perfectly fresh by the officers of the Scottish Fishery Board stationed at the several Fishery districts, they having been requested to send the fish as samples of the takes generally, and not as specially selected for size or otherwise. *

Before stating the actual size of the fish received, the details of localities from which they came, &c., it is necessary to make some qualifying remarks as to how far these samples are a fair representation of the actual size and condition of the fish frequenting the Scottish coasts. They do represent the size of the fish actually caught. Do they cover fairly the sizes of the fish either in their fullest extremes absolutely, or in the proportion in which the varieties of these are present among the whole mass? Now it has to be noted that the size of the fish sent to me for investigation or, to speak more generally, of all the fish brought ashore, is rather an evidence of the size of mesh of the nets employed for their capture than a criterion of the actual size of the herring in the sea; and according to the prevailing size of mesh we shall be liable to misjudge the actual size of the fish. I feel sure that the want of sufficient consideration of this fact, and especially of the circumstance that change of size of mesh has occurred for any period or at any place, has given rise to erroneous ideas as to the preservation or decline of the general or natural size of the herring; for, of course, it must be remembered that a particular size of mesh only takes those fish which fit it, that is to say, does not merely allow the smaller fish to escape by passing through its meshes while sweeping in all the larger, as in a salmon net or seine trawl, but the large fish also to a great extent escape by not getting their heads into the mesh. Leaving out of consideration here the few recorded examples of herring of extraordinary magnitude, most, if not all, of which probably were shad, references to previous observations on the size of the Scottish and North Sea herring do not lead me to think that our herring have retrograded in size. J. Mackenzie,† writing over eighty years ago, divides the Scottish herring into three races—those giving by measurement 800, 1000, and 1500 to the barrel. Valenciennes ‡ gave 10 inches and $10\frac{1}{2}$ inches as the largest, but says North Sea herring may reach $13\frac{1}{2}$ inches long. Mitchell,§ writing twenty years ago, gives the length as 8 inches to 12 inches,—all sizes which, as respects the herring I have examined, appear to be still commonly maintained. Although, however, it is improbable that larger herring than those are represented in any quantity among the shoals which frequent our coasts, I have not much hesitation in saying that a greater number of the larger class of fish are present in the shoals than the takes would lead us to suppose. Some of the largest fish which I received were 'scummed' at Lybster; they averaged 12 inches long, and the means by which these are taken shows how many may escape of similar size, and how almost certain it is that the largest fish seldom become properly meshed. These scummed fish are the large fish which fall out of the net partly from their weight, but often from being insufficiently meshed, and are scummed up by a boy, such fish being generally lost and left dead on the fishing grounds.

A further excellent example, and not the only one, of the influence which

* I have to thank the Fishery officers for the regular way in which they have sent me samples of herrings, and many of them for the suggestive information which accompanied them.

† 'Prize Essays,' vol. ii. *Highland Soc.*, 1803.

‡ Cuv. and Valenc., *Histoire des Poissons*, vol. xx.

§ *Nat. Hist. of the Herring*, 1864.

the mesh has on the size of fish taken, was supplied me by the Fishery officer at Lybster, who sent up two samples of herring taken on exactly the same fishing ground three miles off Dunbeath, and at the same time in August last, but by boats using nets with a different size of mesh. The herrings in one sample, caught in a net which had been in use earlier in the year, and having been rebarked seven or eight times, was consequently shrunk, ranged in length (to end of scales) from 217 mm. to 228 mm., the average length being 224·5 mm. to end of scales, 258·6 mm. to tip of tail. The other sample, caught in a net which had been little used and was considerably wider in the mesh, shows a range in length among the fish of from 230 mm. to 257 mm. (to end of scales), the average being 249 mm. to end of scales, 284 mm. to tip of tail. I need scarcely quote further examples here, for the result appearing in the above is that which we should expect. Nevertheless, in fairness, I must quote an apparent exception, which, however, only shows that with the same size of mesh there may be taken fish having a considerable difference in size, and that the mere presence of a preponderating quantity of large fish in a take does not necessarily though generally point to the employment of a mesh which will not capture small fish.

This example comes from the Fishery officer at Anstruther, and the samples, though taken at different places (in the Firth of Forth) and on consecutive nights, were taken by the same boat and the same net. The length of fish in the first sample ranged from 219 mm. to 248 mm. (to end of scales), the average size being 235 mm. to end of scales and 269 mm. to tip of tail; while the second sample gave a variation in length of from 173 mm. to 220 mm., with an average of 195·7 mm. to end of scales and 226 mm. to tip of tail. It is quite conceivable that circumstances either as to mass or movement of the shoal, weather, tide, &c., may influence the meshing of fish in a net which is rather small for them. But nothing of the kind accounts for the fact apparent in the Lybster sample that small and big fish being certainly present at the same time and place, each net took those fish which were suited to the size of the mesh and let most of the others escape. I have stated the different effects of the net in these cases in terms of the length of the fish, as being more readily understood than would be a comparison of the girth of the fish at the operculum, which of course is the principal factor in this question, and one which I shall hereafter have to refer to; but the rule applicable to the size of the fish in the special cases instanced applies to the size of these fish at the back of their heads also. We must then not be too certain that our conclusions as to the size to which our herring grow, and the relative numbers in which the larger of them are present on our coasts are absolutely correct. That they are so as to the fish actually caught goes without saying.

As to the influence which the common employment of what I may call a small meshed net—for, of course, the use of this term 'small' is relative to the size of the adult fish—may have on the general size of the herring, it can readily be understood that if all fish were meshed, however large, or even if the herring only spawned after reaching their full development (which, as I shall show below, is probably not the case), then there could be little doubt about the great advantage of employing only those nets which, while both bringing the largest fish only to the market, would, by allowing the smaller and younger to escape, not only permit them to grow up, and thus increase the supply of the larger, but also have a fair chance of doing so by the increased number of spawners. But as things are, it is questionable whether by a moderate size of mesh we are after all doing anything to deteriorate the size of our fish; whether indeed we are not directly helping to increase their size. For if we employ a mesh which

will take only the large fish, we shall certainly reduce the number (possibly, almost certainly not to a serious degree considering the present enormous numbers of the herring, but still to some extent), of those large spawning herring, and the greater will this become the case as the fishing industry increases. The more we take these large herrings the less opportunity will they have of depositing their spawn, because it must be remembered that practically we limit our fishing by this very condition, striving to get the herring *before* they have spawned and when nearly ripe, the spent fish falling off in condition, and therefore in commercial value, and also getting beyond our reach by forsaking the spawning ground. Now, were this the only result of the large mesh it would little affect the general size of the fish as we get them,—would be advantageous indeed so long as the actual spawners left in the sea were sufficient to naturally keep up the supply, or their decrease was made up by artificially hatched or reared young. But it is undoubted that spawning herring very much smaller than what are commonly called large fish, are present in enormous quantities on our coasts every year for the purpose of depositing their ova.* When one asks the meaning of the term matie, the answer generally is, that it is an immature fish, a rather indefinite term, unless it is qualified by an explanation of whether it applies to the growth of the fish as a whole, or only to the condition of the sexual organs, but as matter of fact the great proportion (at least after the very beginning of the fishing season and judging by my samples) of these maties, are fish which, small either 'racially' and therefore fully grown, or small because young and having arrived at sexual maturity before having reached their full size, are either actually spawning or will very shortly do so. It matters little in an argument as to size of mesh whether these spawning maties are a small variety or young fish, the fact remains that the descendants of the former will be small for the same reason that their parents are so, and as to the latter, analogous cases lead us to the same conclusion, although in the latter case they may be always recruiting the ranks of the larger. If, then, the mesh of the nets is enlarged so as to allow these small spawning fish to escape, we encourage the smaller individuals, through their whole existence if they are adult herrings, or if they are only young fish we protect them while they and their ova are small and likely to produce small progeny, taking them with the large mesh only when they reach a condition suitable for improving the size of the race. I shall have to refer later on to the presence of these small spawners among the larger, but the taking of the big fish alone would have a tendency not only to reduce the actual numbers, but indirectly the increase of the race by the loss of their spawn, and it would reduce also that correction of the small size among the herring, which must be caused by the interbreeding of the large and small, and which almost certainly takes place.

I have noticed this matter entirely as it may affect the size of our herring (and even in this view too much stress must not be laid on it), and not at all in its commercial aspects, in respect to which many other con-

* The Scottish Fishery Board Reports show how much larger a number of barrels of maties are cured than of the other classes of herrings, and as the maties are smaller than the others, the proportion in numbers must be much larger. Yet most of these 'maties' are small fish which will spawn during the current season, and, as the name is generally employed now, they include many wholly ripe or nearly ripe herrings. A convenient example, out of many such, to quote as showing that the term matie as now used in Fishery Districts by no means indicates immature herrings is the following:—Of four fish sent from the N.E. coast, two were labelled 'full,' the other two, which were considerably smaller, being marked 'maties.' Examination, however, showed that the so-called maties were fully ripe, while the larger 'fulls' turned out to be scarcely half ripe—they would probably not have spawned for several weeks.

siderations come in, as the loss of capture of the large fish, the very remote chance of the take of the small fish becoming so extensive as practically to prevent any addition to the numbers of the large, &c. Only it is well to note that the restriction of our means of catching the herring to such as will secure only the larger fish may not therefore be followed by an increase or even retention of the present size of the herring. So far, however, as regards the numbers of the herring, and to a certain extent also as regards their size, the effect of a mesh which takes fish below the size of spawners, *i.e.*, fish immature both as to general growth and sexual condition, is very different.

The recognition of these immature fish by their size alone is surrounded by considerable difficulties, dependent principally on the great variations in size in conjunction with sexual maturity, which occur not only among the herrings of different localities or seasons, but in the same shoals. Still a general idea, such as given below of the fullest size of these immature fish, may be arrived at and used as a rough guide in their identification. But it would seem that much more importance should be attached, if these immature fish are to be protected, to the date at which the herring fishing commences. The quality of the takes examined appears to point to the fact that in the early part of the fishing season, where that is not restricted, a large proportion of the fish captured, are comparatively small and quite immature. During the height of the season, I think not many, proportionately, of the fish taken are sexually immature. It is supposed by some that these immature early fish are coming shorewards as a preliminary to spawning, and though yet apparently immature, will increase in size and ripeness, and will spawn during the current season. I am inclined, without any actual proof, to think otherwise. If the adult herring came to the spawning banks in a sexually very early, or, apparently immature condition for the purpose of spawning when ripe, we would have more reason from the apparent similarity in their sexual condition to think these small fish might do so also; but we almost never see an adult herring without its roe and milt being fairly developed at least considerably beyond their earliest condition, unless indeed in its shotten stage, and I think I may be able to show that probably the earlier development of the ova is much slower than the latter stages. Now when we do find the ova in a very early stage it is generally, not always, so found in the smaller fish, I believe for the reason that the larger and older herrings, while in this condition, are not near the spawning beds, and I take it, from this and other appearances, that these are generally young fish spawning for the first time, and which are caught a considerable time before they are ripe, because they as young fish have been frequenting the inshore waters, and are not there for the direct purpose of spawning. It is probable that these immature fish which are taken early in the season and seem to be the harbingers of the great shoals, would be found much more often and in greater numbers than we usually suppose, were only the means at hand, viz., the men, nets, and boats, for testing this question, during a still earlier part of the season, or during the off-fishing season itself. Moreover, it is quite likely that these shoals of young herrings are induced to travel shorewards, even if their natural instinct is not towards it at that age, by the gradual approach of the spawning fish, a good many among which, especially of the smaller ones, are mixed up among the immatures at this early period.

When we turn to the consideration of the size, principally as represented by length, of the herring caught around the Scottish Coasts we are met by the difficulty at the outset that we cannot be sure that those

TABLE (I.) of largest Herrings (above 300 mm. long to tip of caudal fin).

No.	Date of take.	Fishery District.	Sex.	Length in mm. to end of scales.	Length in mm. to tip of caudal fin.
1	7.8.85	Shetland.	?	291	333
2	23.1.84	Findhorn.	*f.*	291	325
3	30.1.84	Helmsdale.	*f.*	290	330
4	13.2.85	Wick.	*f.*	289	328
5	23.1.84	Findhorn.	*f.*	288	330
6	7.2.84	Wick.	*m.*	287	328
7	5.2.84	Buckie.	*f.*	285	328
8	23.2.84	Wick.	*m.*	285	328
9	9.1.84	,,	?	285	327
10	26.1.84	,,	*m.*	285	320
11	23.1.84	Buckie.	*m.*	284	328
12	22.1.84	Wick.	*f.*	282	324
13	7.2.85	Buckie.	*f.*	282	321
14	19.2.84	,,	*m.*	282	320
15	26.3.84	Girvan.	*f.*	282	320
16	11.3.85	,,	*f.*	282	319
17	20.2.85	Wick.	*f.*	281	322
18	7.2.85	Helmsdale.	*m.*	281	320
19	5.2.85	,,	*m.*	281	318
20	8.7.85	Inveraray.	*m.*	280	326
21	16.1.85	Peterhead.	*f.*	280	321
22	13.2.85	Buckie.	*f.*	280	320
23	9.3.85	Girvan.	*f.*	280	315
24	31.1.85	Wick.	*f.*	279	321
25	8.2.84	Findhorn.	*m.*	279	318
26	23.1.84	Aberdeen.	*m*	279	315
27	20.1.85	Helmsdale.	*f.*	279	314
28	7.2.84	Wick.	*f.*	278	317
29	8.2.84	Findhorn.	*m.*	278	312
30	7.2.85	Buckie.	*f.*	277	312
31	30.1.84	,,	*f.*	276	318
32	13.2.84	Stonehaven.	*f.*	276	316
33	5.2.84	,,	*f.*	276	315
34	18.8.85	Lybster.	*f.*	276	315
35	9.3.85	Girvan.	*f.*	275	323
36	8.2.84	Buckie.	*f.*	275	319
37	7.2.84	Wick.	*f.*	275	317
38	13.2.84	Findhorn.	*m.*	275	317
39	6.2.84	Banff.	*f.*	275	316
40	14.2.84	Helmsdale.	*m.*	275	314
41	11.3.84	Girvan.	*f.*	275	311
42	11.3.85	,,	*m.*	275	306
43	16.3.84	,,	*f.*	274	314
44	26.8.85	Aberdeen.	*m.*	274	314
45	7.3.85	Girvan.	*m.*	274	309
46	14.2.85	Helmsdale.	*f.*	273	313
47	29.1.84	Aberdeen.	*f.*	273	311
48	26.1.84	Lybster.	*f.*	272	317
49	12.2.85	Helmsdale.	*f.*	272	315
50	12.8.85	Stonehaven.	*sp.*	272	312
51	4.2.84	Girvan.	*m.*	272	310
52	13.2.84	Buckie.	*m.*	272	308
53	26.1.84	Wick.	*m.*	271	313
54	17.1.84	Aberdeen	?	271	311
55	6.9.84	Shetland.	*f.*	271	310
56	6.9.84	Girvan.	*f.*	271	310
57	7.2.84	Peterhead.	*f.*	271	308

TABLE I.—*continued.*

No.	Date of take.	Fishery District.	Sex.	Length in mm. to end of scales.	Length in mm. to tip of caudal fin.
58	8.2.84	Girvan.	*f.*	271	300
59	21.1.85	Stonehaven.	*sp.*	270	314
60	15.3.84	Shetland.	*m.*	270	313
61	2.12.84	Findhorn.	*f.*	270	310
62	1.2.84	Wick.	*f.*	270	309
63	2.6.85	Fraserburgh.	*f.*	270	309
64	29.1.84	Aberdeen.	*m.*	270	308
65	19.2.85	Buckie.	*m.*	270	308
66	6.2.84	,,	*f.*	270	307
67	7.2.84	Wick.	*m.*	270	307
68	16.1.85	Peterhead.	*f.*	270	304
69	12.2.85	Helmsdale.	*m.*	270	303
70	5.2.85	,,	*f.*	270	300
71	26.1.84	Lybster.	*m.*	269	314
72	6.2.84	Peterhead.	*m.*	269	314
73	13.2.85	Wick.	*f.*	269	310
74	12.2.84	,,	*f.*	269	303
75	4.4.84	Campbeltown.	*m.*	269	303
76	13.2.84	Findhorn.	*f.*	268	313
77	18.1.84	Montrose.	*f.*	268	310
78	22.2·84	Loch Broom.	*f.*	268	306
79	8.2.84	Girvan.	*f.*	268	304
80	2.9.85	Stonehaven.	*f.*	268	302
81	9.1.84	Girvan.	?	267	308
82	6.2.85	Wick.	*f.*	267	308
83	24.3.84	Girvan.	*m.*	267	307
84	28.2.85	Wick.	*f.*	267	300
85	5.2.84	Helmsdale.	*m.*	266	306
86	12.2.84	,,	*m.*	266	306
87	18.2.85	Girvan.	*m.*	266	306
88	8.1.84	Aberdeen.	?	266	304
89	5.2.84	Helmsdale.	*f.*	266	304
90	1.2.84	Wick.	*m.*	266	301
91	18.2.85	Girvan.	*f.*	265	306
92	16.1.85	Stonehaven.	*m.*	265	305
93	15.3.84	Buckie.	*f.*	265	304
94	25.2.85	Helmsdale.	*m.*	264	304
95	18.1.84	Montrose.	*m.*	264	302
96	8.2.85	Buckie.	*m.*	264	302
97	23.1.84	,,	*m.*	264	301
98	16.1.85	Stonehaven.	*m.*	264	300
99	21.8.85	,,	*f.*	263	303
100	14.2.84	Girvan.	*f.*	263	301
101	6.9.84	Shetland.	*f.*	262	303
102	13.2.85	Buckie.	*m.*	262	300
103	21.2.85	Fraserburgh.	*f.*	261	301
104	23.6.85	Inveraray.	*m.*	261	301
105	21.8.85	Aberdeen.	*f.*	261	301
106	22.2.84	Loch Broom.	*f.*	261	300
107	21.8.85	Stonehaven.	*f.*	260	301
108	17.1.84	Aberdeen.	?	260	300
109	18.1.84	Buckie.	*f.*	260	300
110	1.2.84	Peterhead.	*f.*	260	300
111	11.3.84	Girvan.	*m.*	260	300
112	25.1.84	Helmsdale.	*f.*	258	306
113	18.8.85	Montrose.	*m.*	258	300
114	18.8.85	Wick.	*m.*	256	300

included in our measurement are all fully developed fish, even although only those with well developed milt and roe are considered. And so, while by examination we may be able to ascertain pretty accurately the limit of size over which the herring is not or is seldom found in an immature condition, we cannot, with our present want of knowledge of the age of the fish above that standard, be sure whether we are unduly lowering the average size by including spawning but not fully grown fish (and which we to some extent are almost certainly doing), or whether all these spawning fish are typical adult specimens, but of widely varying dimensions.

In measuring the herrings sent to me I have included, for this purpose, all those which have the roe or milt developed, even although in some cases they were smaller than actually immature fish. I have given my reasons for considering most of those small herrings with but slightly developed roes and milts to be young fish, but the number of those included in the measurements given below are too few to seriously affect the result; only we ought to recollect that the sizes given cannot be overstated, having been actually measured, while they may indicate rather a less value than is just, both from the inclusion of not fully grown fish and the absence of the largest.

The absolutely largest fish which reached me are given in the preceding table (I.), for the purpose of showing the general extreme (not by any means the altogether largest) size of the herrings brought ashore, but principally to show that the largest class of fish are to be met with in almost every fishing district around the coast. It also shows that the majority of these large fish were taken during the winter fishing, and although it is not so stated in the table, they were all from fishings less than 5—generally less than 2—miles off shore, with the exception of Nos. 39, 53, 76, and 104, which were taken 10 miles, Nos. 51 and 64, 20 miles, and Nos. 60, 98, and 106, 30 miles off the land. It may also be noticed that there was a larger number of roe than of milt fish among them, but no special distinction in size in respect to sex could be drawn between these.

The largest fish included in the table, taking into account both length and bulk, was No. 21, which weighed $12\frac{1}{2}$ oz.

The following table contains the average size per month of the fish measured, arranged according to the localities from which they came.* In one or two cases the fish, although landed at and sent to me from one fishing district, were caught much nearer another, and in such cases I have allowed for this, of course preferring the actual place of capture to the mere place of delivery; therefore, to avoid confusion, I have limited the list of localities to the regular districts of the Fishery Board for Scotland.

* Unless otherwise stated, the lengths given in this paper are measured from tip of lower jaw to end of scales (see p. 63).

[TABLE

TABLE (II.) of Average Lengths in mm. of HERRINGS, compiled from measurement of 1230 Fish. (The first column under each month gives the length to end of scales, the second to tip of caudal fin).

DISTRICT		January.		February.		March.		April.		May.		June.		July.		August.		September.	
Girvan,	1884	225	259	222	256	244	277	.	.	223	252	230	260	.	.	.	.	.	.
	1885	231	261	224	255	252	285	.	.	233	263	220	252	222	255	.	.	.	.
Inveraray,	1884	.	.	.	.	.	.	.	.	208	234	232*	260	.	.	.	.	.	.
	1885	.	.	.	.	.	.	.	.	.	.	235	272	245	281	.	.	.	.
Campbeltown,	1884	.	.	.	.	.	.	215	247	220	251	216	248	.	.	.	.	.	.
	1885	.	.	.	.	.	.	.	.	.	.	221*	251	239*	274	.	.	.	.
Loch Broom,	1884	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	1885	.	.	241	275	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Stornoway,	1884	.	.	.	.	.	.	239	273	236	264	222	253	.	.	.	.	.	.
	1885	.	.	.	.	.	.	.	.	237	269	216	248	237	273	.	.	.	.
Wick,	1884	250	286	253	289	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	1885	259	298	259	296	242	276	.	.	.	.	210	241	223	257	230	264	234	369
Lybster,	1884	233	267	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	1885	194*	225	.	.	.	.	.	.	.	.	.	.	232	268	222	256	218	.
Helmsdale,	1884	249	288	244	280	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	1885	259	291	256	291	240	272	247	284	.	.	.	.	.	.	.	.	.	.
Cromarty,	1884	222	253	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	1885	197*	224	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Findhorn,	1884	260	294	254	291	247	284	.	.	.	.	208*	240	.	.	.	.	.	.
	1885	.	.	.	.	.	.	.	.	.	.	.	.	217	254	.	.	.	.
Buckie,	1884	251	288	239	274	239	271	.	.	.	.	.	.	.	.	.	.	.	.
	1885	.	.	246	280	241	274	.	.	216*	243	200*	229	221	255	.	.	.	.
Banff,	1884	.	.	231*	267	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	1885	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fraserburgh,	1884	.	.	.	.	.	.	226*	260	.	.	215*	246	.	.	.	.	.	.
	1885	.	.	249	285	.	.	.	.	.	.	.	.	223	259	230	264	.	.
Peterhead,	1884	250	288	256	296	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	1885	267	302	.	.	.	.	.	.	.	.	.	.	216	249	216	248	.	.
Aberdeen,	1884	259	296	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	1885	.	.	.	.	.	.	.	.	.	.	.	.	.	.	237	272	225	.
Stonehaven,	1884	244	279	248	285	.	.	213	241	217	247	198	226	.	.	.	.	.	.
	1885	247	285	.	.	.	.	.	.	.	.	206	235	217	251	227	263	256	294
Montrose,	1884	221	255	213	243	210	242	.	.	.	.	.	.	.	.	.	.	.	.
	1885	.	.	.	.	.	.	.	.	.	.	.	.	222	257	230	266	237	273
Anstruther,	1884	225	257	229	261	224	253	212	242	.	.	.	.	.	.	.	.	.	.
	1885	235	267	.	.	.	.	.	.	221	248	236*	271	221	254	.	.	.	.
Leith,	1884	.	.	.	.	182*	204	.	.	.	.	.	.	.	.	.	.	.	.
	1885	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Berwick,	1884	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	240	270
	1885	272	307	.	.	.	.	.	.	.	.	201	230	231	267	223	258	226	262
Orkney,	1884	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	1885	.	.	.	.	.	.	.	.	.	.	.	.	.	.	224	260	.	.
Shetland,	1884	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	267*	309
	1885	.	.	.	.	.	.	.	.	.	.	.	.	.	.	229	265	.	.

* Scarcely reliable, being calculated from a small number of Herring.

Including the average for both years, and collecting them into periods of three months, which fairly represent the fishing seasons, so far as my samples permit, we get the following table of results :—

TABLE (III.) of Lengths of HERRINGS, arranged according to Localities and Seasons, of 1884 and 1885.

FISHERY DISTRICT.	Average Lengths in mm.						Extreme Lengths (to end of scales) in mm.					
	Jan., Feb., March.		April, May, June.		July, August, Sept.		Jan., Feb., March.		April, May, June.		July, August, Sept.	
							Max.	Min.	Max.	Min.	Max.	Min.
Girvan,	233	265·5	226·5	256·7	222	255	282	175	256	201	238	199
Inveraray,	...	...	228·6	260·3	245	281	...	...	261	182	280	224
Campbeltown,	...	...	217·8	249	239*	274	...	...	269	191	255	227
Loch Broom,	241	275	...	...	...	...	259	197	...	...	...	...
Stornoway,	...	...	231·5	263·3	237	273	...	...	261	205	247	228
Wick,	250·8	286·8	210	241	229	263·3	289	219	215	204	258	203
Lybster,	213*	246	...	...	224	260	272	194	...	...	276	185
Helmsdale,	248	282·3	247	284	...	...	290	212	251	243	...	...
Cromarty,	209*	238·3	...	...	...	...	258	178	...	...	...	...
Findhorn,	253·6	289·6	208*	240	217	254	279	213	218	199	222	215
Buckie,	244·5	279	208	236	221	255	285	205	235	197	253	196
Banff,	231	267	...	...	...	...	275	188	...	...	...	...
Fraserburgh,	249	285	220·5	253	226·5	261·5	261	237	245	207	270	202
Peterhead,	257·2	295·5	...	...	216	248·5	281	230	...	...	240	200
Aberdeen,	259	296	...	...	231	266	279	237	...	...	274	197
Stonehaven,	246·7	283·5	210·6	239·5	233·3	269·3	276	185	257	180	272	187
Montrose,	214·6	246·6	...	...	229·6	265·3	268	190	...	...	261	202
Anstruther,	227·6	258·6	223	253·6	221	254	265	197	236	207	253	188
Leith,	182*	204	...	...	...	...	215	172	...	...	...	...
Berwick,	272*	307	201*	230	229	263·6	297	255	213	190	264	196
Orkney,	...	...	...	...	224	260	...	...	...	...	233	207
Shetland,	...	...	...	...	248	287	...	...	...	...	291	190

* Calculated from a small number of Fish.

The period April, May, June, has been purposely arranged to contain a record of such fish as are caught during that time, and of which it is difficult to say whether they are stragglers remaining from the winter, or precursors of the summer fishery. By keeping them apart, the principal periods will not be influenced, in the event of some special distinction between the fish of these two periods appearing to obtain.

The latter table shows that practically not only the medium-sized, but also the largest and smallest fish are represented in all the districts; for the slight fall in the maximum size in the two districts of Montrose and Anstruther, lying as they do contiguous to and between Stonehaven and Berwick, does not appear to me of much importance. The same remark applies to Fraserburgh. The specimens from Leith and Cromarty were taken near the Beauly Firth and in the Firth of Forth respectively, and probably were first year's spawners.

So far, then, as extreme limit of size goes, we can scarcely say that in that respect there are herring peculiar to any one district. Some of the averages in the tables, owing to the small number of fish at my disposal, are, perhaps, scarcely fair statements of the prevailing size of the fish frequenting the locality; these I have indicated by an asterisk; as to the others the table indicates that no very broad distinction can be drawn between the fish from different localities, so far as their general size is concerned. Where there is a difference in the average size it will often be found occurring among fish from the same locality and in consecutive months. But this distinction as regards time, not place, is often really not so great as it seems; for it appears from more minute examination of the figures (although the table does not show it), that the difference is caused by considerable variation in size of those herrings which have been procured so nearly at the same time—within a few days of each other, although not in the same month,—that this difference cannot satisfactorily be founded on for placing them in separate varieties. Further, the same difference may appear between the fish procured in the same waters, and at the same date, but in different years. As regards locality those of the North-East Coast have, if anything, the highest averages during the winter and spring season, the West Coast and the South-East following. Taking the highest and lowest average lengths in the period—January, February, March—we find the greatest difference is 90 mm., a relatively large variation; but if we leave out the insufficient samples from Berwick, Leith, and Cromarty, the difference becomes reduced to 46 mm. ($1\frac{3}{4}$ inches). In July, August, and September, the difference is 32 mm. ($1\frac{1}{2}$ inches). A reference to the monthly table of averages shows considerable variation in size in the same district. When we examine the summer averages, we scarcely perceive any difference between the fish in each locality, but we do see a certain reduction in the value of the figures as compared with those of the winter season, and the exceptions in the table are found to be more apparent than real, when we come to examine singly the figures which compose these averages, on which the actual number of fish included has occasionally a slightly irregular effect.

The higher average of size among the winter fish than among the summer is better seen in the following table of the percentage of fish received during the three periods already referred to, as the division of the fish into their localities is ignored in this table, and they are treated as a whole. The table is, of course, only of value if we grant that the differences shown in the table of averages are insufficient to constitute special local varieties.

TABLE (IV.) of percentage of Herrings arranged according to length of Body.

Length of fish to end of scales in mm.		170 to 179	180 to 189	190 to 199	200 to 209	210 to 219	220 to 229	230 to 239	240 to 249	250 to 259	260 to 269	270 to 279	280 to 289	290 to 300
Percentage of fish in Jan., Feb., March,	1884	·3	·9	3·5	8·2	13·0	10·0	10·2	13·7	16·0	12·0	8·2	3·0	·9
	1885	3·0	·6	2·3	2·9	6·3	9·7	15·3	18·7	9·7	14·0	9·0	6·8	1·7
Percentage of fish in April, May, June,	1884	...	2·6	8·8	18·4	22·0	15·0	16·6	7·0	8·0	1·7	...	...	...
	1885	...	...	5·6	15·0	24·5	17·0	15·0	17·0	3·8	2·0	...	...	...
Percentage of fish in July, August, September, 1885		...	1·7	3·5	12·0	17·7	21·8	19·4	12·0	7·8	1·7	1·5	·6	·3

Here it will be seen again that the fish examined were found of all sizes, irrespective of the season of the year, the summer and winter herrings both ranging, though in different proportions, over nearly the whole scale—*i.e.*, from 170 mm. to 299 mm. in length. But it also shows more clearly than the other tables that the majority of the herrings taken during the winter months fell within the limits of 210 mm. to 270 mm. (there is a slight difference between the percentages in 1884 and 1885, the majority of the latter being condensed into a smaller area, 220 to 269, than the former, but this does not alter the result otherwise), while the majority of the summer fish, larger even than that of winter, measured from 200 mm. to 249 mm. The percentage of the spring fish (*i.e.*, those taken at the end of the winter or beginning of the summer fishing), agree most nearly with the latter, the percentage of the smaller fish being even greater; which probably means that most of them were lately immature, and thus early on the spawning banks,—though not necessarily to immediately spawn, for all the fish in these tables are fish in every stage of ripeness, from the early to the full condition, including also a few spents, but no immature fish. I have, however, received information from the Fishery officers as to the number of meshes per yard in the nets principally in use during the fishing seasons, and from which the herring samples were procured for me, and although the size of the mesh appears often to be the same both in winter and summer, it is the custom in many places to use a larger mesh in winter (except at Anstruther, where the reverse was the case), due generally to the fact of the nets being at that season new and not shrunk by barking. This consideration reduces rather further the slight difference in size which appears between my winter and summer samples.

The immature fish which are not included in these tables, but most of which were caught in the regular herring fishing along with the mature, were not very numerous. Those taken during the early months of 1884 varied in length from 142 mm. to 203 mm.; during the same period of 1885 only half a dozen were received from 174 mm. to 205 mm. long; the length of those caught during April, May, and June 1884 and 1885 was from 162 mm. to 229 mm.; those caught in the summer of 1885 measured from 154 mm. to 219 mm.

It will be seen that some of these immature fish exceed in length a few of the actual spawning fish. While these immature fish, however, are found as much as 230 mm. in length, in the large spawning shoals of herring it is only a very small percentage that are so large, the great proportion being less than 210 mm. long.

The maties, using the term as including the smaller sexually mature fish, range in length from 170 mm., of which size there are extremely few, to a size which, of course must be fixed quite artificially, and there can be no

reason for doing so except in so far as the question is often asked, Below what length is a herring a matie? If the correct meaning of immature is strictly applied to the matie, the size given above for these would fairly answer the question; but, if the matie is to be considered simply as a young herring, irrespective of its sexual condition, perhaps spawning—but not yet being fully grown—we could scarcely be safe in putting its length higher than 205 or 210 mm., which is considerably below what is often called a matie at present. Of the herring sent up from the various districts for this investigation, 12 per cent. of those in a sexually mature condition, *i.e.*, more or less ripe or spent, were under 210 mm. long to end of scales, and 230 mm. to tip of tail.

In considering the size of the herring there is another measurement than that of length which has to be taken into account, that is, the depth and girth of the fish. Without going into detail, it may be said that the depth of the mature herring caught during or near to the time of spawning is almost wholly influenced in its extent by the condition of the reproductive organs; and so many variable degrees of these are found that any measurement of the depth of the body proper is most unsatisfactory as a test of the size of the fish, and only of interest in connection with the amount of development of the roe or milt.

There is, however, a point which gives a fair index of the size of the fish in this respect, and which is but very little affected by the size of the generative organs. This is the depth of the fish at the anterior end of the body, in a line with the back of the head, the upper point being fixed by the dorsal surface of the supra-occipital bone, the lower by the ventral edges of the clavicles of the shoulder girdle. Posterior to this, even so little as in a line with the back of the operculum, the measurement is so variable as to be untrustworthy.

Table V. gives the result of the measurements made of the depth of the herring at this point. For reasons which will afterwards appear, the depth is taken in parts of the length of the body only, *i.e.*, the varying lengths of the head and tail are excluded. The body depth at the part referred to does not vary much in the mature fish, the extremes being ·18 and ·23 of the length of the body, found in fish measuring 214 mm. and 254 mm. in length of body respectively, these examples giving a depth of from ·12 to ·17 of the total length to the tip of caudal fin. Among the immature fish it varies from ·17 to ·23, found in fish measuring 180 mm. and 190 mm. in length of body respectively; that is to say, among the immature fish the depth of body has a range of variation, and holds a proportion to the length almost identical with that of the mature. If, for convenience, the amount of this variation be formed into five equal divisions, we find the percentage of fish included in each to be as follows:—

TABLE (V.) of Herrings arranged according to depth of body.

Ratio of depth to length of body (minus head and tail).	·170 to ·180	·181 to ·192	·193 to ·204	·205 to ·216	·217 to ·228
Percentage of Mature.	1·4	24·5	39·6	27·0	7·4
Percentage of Immature.	12·2	36·6	20·7	18·3	12·2

This table shows that although the mature and immature fish are found covering a common ground of variation, the immatures in general have a slightly less depth at the shoulder, relatively to the length of the body (only) than the mature. A further and detailed examination of each of the mature fish included in the figures of this table shows that the relative depth of the body is not altogether affected by the length of the fish, all lengths being represented in each of the above divisions.

Regarding what is generally called the size of the herring, that is, its bulk, opinions differ very much; but there seems to be a general belief that the fish vary in this respect according to the locality which they frequent, and that such variation is pretty constant. The tables given above show that so far as length and size at the shoulder go, there is not such a marked difference between our local forms as is often supposed; but in respect to bulk there is some ground for the belief. This is not so much due, I think, to an actual difference in the size of the fish, as partly to the difference in the size to which the roe or milt attains, and especially to the amount of fat developed before the spawning season. For instance, the Campbeltown and neighbouring herrings seem to have larger roes and milts, when fully ripe, than those of the South-East Coast of Scotland, and there is nearly always to be found in them, especially in those frequenting Loch Fyne, a much larger quantity of fat along the intestine, air bladder, &c. This has a considerable influence in the estimation of size by bulk, but it does not necessarily mean a longer or even deeper fish, as may be seen when they are compared without these adjuncts, as, for instance, in the spent condition. Of course, in estimating the size of these herrings, care must be taken only to compare those in actually the same sexual condition; for estimation by cran measurement will be influenced a good deal by this, even where the herrings are supposed to be assorted into fulls, spents, maties, &c. Lastly, the size of mesh generally in use in the various localities will affect these results.

From this examination of the general size of the herring at all seasons and in all localities around Scotland, it appears to me inadvisable to lay too much stress on the not very extensive differences of length which are found among them, as indicating that these herring belong to more than one race or variety. The difference apparent in such a comparatively limited examination as we can undertake may be partly caused by circumstances attending the capture of the fish. But there can be little doubt that the effect of temperature, not only on the developing ova, but more especially on the young and growing fish, as well as the amount of food at their command, must have considerable effect on the ultimate size of the fish, and these effects—perhaps considerable in one season so far as the numbers of fish go, only to be corrected in another more favourable—will to some extent influence the proportion of small and large fish in the shoals frequenting the spawning grounds. We can scarcely, then, I think, distinguish as regards size the herring of any particular locality, or, perhaps, even seasons, by a preference over the others, without further confirmatory evidence, such as might be brought out by an examination of differences in other characteristics and the common presence of one or more of such specially in the fish of any one place or season.

Size of Head.

In dealing with this question, as well as with the position, length, &c., of fins and other external characters, the results, so far as yet worked out, must be stated in even more general terms than was necessary in referring to the size of the whole fish. We can scarcely class the herrings under

separate varieties or races as regards these characters unless we find either a special peculiarity in respect of one character prevalent in any one place or at any one season, and conspicuous by its absence elsewhere, or else if we find two or more, perhaps not so strongly marked characters generally present together, and limited to the fish of a particular locality. Now, in order to ascertain in what manner and to what extent any of the many variable characteristics of the herring are found in combination a very extensive and minute examination of the condition of these in each single fish is requisite; and then is required a reduction of the almost certainly large number of combinations into more broad general classes, and the application of these to localities or seasons.

This part of the investigation is not yet complete, and we can meantime only view each character as it is represented on the herrings as a whole body, and in particular localities or seasons, but not in its relation to the other characters on each individual fish.

A very cursory examination of the measurements of the length of head shows at once that the dimension of the latter relatively to the size of the fish is extremely variable.

In the mature winter fish of 1884, which were measured, the length of head varied from ·127 in two herrings of 235 mm. and 265 mm. long respectively, to ·200 in a fish of 240 mm. long. In the spring months the variation was ·140 to ·200. In the winter of 1885 the extent of variation was from ·137 in a fish 270 mm. long to ·200 in a fish 220 mm. in length; and in the summer of 1885 it varied from ·135 to ·196. It will be seen that the variation towards the larger extreme appears in all the seasons to stop almost at the same point—the head does not exceed ·2 of the length of body (equivalent in the actual fish representing these conditions to about ·173 of the total length). Towards the other extreme, the extent of variation is rather more unequal. In the immature fish examined, the variation extended from ·145 to ·200, the herrings of all the seasons being represented up to the extremes of these limits. It must, however, be understood that these extremes of variation were only found in a very few and therefore exceptional cases. The large proportion of the fish fell within a much smaller though well-marked range of head variation.

Including all the immature herrings of both winter and summer we find that only 6 per cent. of them have the length of head of a greater proportion to the body length than ·156, and the majority—about 60 per cent.—have the head length ranging between ·166 and ·180 of the body length. The extent of variation among the mature herrings is all towards the side of decreased length of head, the larger proportion having it between ·151 and ·165, and is rather more marked among the summer fish, among which the larger fish have the relative size of their heads generally less than this. Among the winter herrings, however, although the extent of variation is equally great, the large fish seem to be more indiscriminately scattered over the whole area of variation. It is undoubted that the immature herring's head is relatively larger than that of the adult, and the increase in relative size becomes emphasised the smaller the young fish may be. There would appear also to be a tendency among the sexually mature fish to increase in size of body rather quicker than in head length, this being seen among the smaller, and presumably therefore, younger although ripe fish. Table VI. gives the percentage of fish (in a total of 865) whose head length fell within the various degrees of variation, marked at the head of the columns in the table.

The great proportion of these herrings have their heads of a relative length of from ·143 to ·172—indeed it might be said from ·146 to ·166; and the table indicates that, as with the body length, all the extremes of

proportion of head length are to be found in the herrings of both seasons, although the percentage of long heads is rather greater in winter than in summer. Here again, then, if we do not consider the slight difference in total length found between the winter and summer herrings sufficient to indicate a distinct variety, neither is there stronger evidence from the length of head.

TABLE (VI.) showing Percentage of Sexually Mature Herrings, arranged according to Head Length.

	Ratio of head length to body length....	·127 to ·138	·139 to ·150	·151 to ·162	·163 to ·174	·175 to ·186	·186 to ·198
Percentage in	Jan., Feb., March 1884 and 1885..	3·6	15·3	38·2	30·2	10·2	2·5
	July, Aug., Sept. 1885	1·5	22·3	50·0	24·0	1·8	·3

TABLE (VII.) showing Percentage of Immature Herrings, arranged according to Head Length.

	Ratio of head length to body length....	·147 to ·150	·151 to ·162	·163 to ·174	·175 to ·186	·187 to ·202
Percentage in	Jan., Feb., March 1884 and 1885..	2·6	18·0	34·0	35·0	10·4
	July, Aug., Sept. 1885...............	6·5	13·0	61·3	16·0	3·2

Note.—The variation scale is here for comparison divided, as in Table VI.; the 1st division is therefore small, the scale among immatures not passing below ·147.

In Table VII. we find a much larger percentage of what may be called the long-headed herrings among the winter than we do among the summer immature fish, which is in accordance with what has just been stated; for if we turn to the statement (p. 75) of the body lengths of the immature fish, from which Table VII. is compiled, we see that the immatures received during winter were considerably smaller than those of the summer season; and as the length of head among immatures (at least to a much less size than those we are here discussing) is in inverse ratio to their length of body, we expect to find the winter-season examples—the majority being smaller fish—with the relatively longer heads.

This circumstance—that the immature fish received in winter were smaller than those of summer—may appear to indicate that the fish of the two seasons were of one and the same hatching, the small winter immatures having grown some 30 mm. in length, and forming the larger immature fish of summer. Whether this be so or not must be left to be decided by the examination of the combined characters. The difference in length is not so valuable as it might otherwise be, from the circumstance that about half of the winter immatures were procured by specially small meshed nets.

The question of locality only now remains to be considered, and the result of an examination for that purpose is given in the following table:—

TABLE (VIII.) showing distribution of HERRINGS in the different Localities, arranged according to Length of Head.

January, February, March, 1884 *and* 1885.

Ratio of Head Length to Body Length.	·127 to ·138	·139 to ·150	·151 to ·162	·163 to ·174	·175 to ·186	·187 to ·198
Girvan,	·7	8·2	30·8	38·3	20·0	2·0
Inveraray,	...	...	...	...	...	...
Campbeltown,	...	...	...	...	...	...
Loch Broom,	...	10·0	30·0	50·0	10·0	...
Stornoway,	...	...	...	...	...	...
Wick,	4·5	29·5	45·5	20·5	...	...
Lybster,*	...	...	25·0	50·0	25·0	...
Helmsdale,	8·0	18·0	34·0	28·0	10·0	2.0
Cromarty,*	...	...	33·3	...	66·6	...
Findhorn,	...	33·2	42·8	19·0	...	5·0
Buckie,	2·5	10·0	45·5	34·5	6·2	1·3
Banff,*.	50·0	...	...	...	...	50·0
Fraserburgh,*	...	...	100·0	...	...	...
Peterhead,	...	28·5	64·3	7.2	...	...
Aberdeen,	7·7	23·1	61·5	7·7	...	...
Stonehaven,	...	24·0	56·0	20·0	...	...
Montrose,	22·2	22·2	22·2	22·2	11·1	...
Anstruther,	4·8	9·7	48·4	35·5	1·6	...
Leith,*	...	...	...	50·0	...	50·0
Berwick,	...	14·3	14·3	57·1	14·3	...
Orkney,	...	...	...	...	...	...
Shetland,	...	...	...	...	...	...
July, August, September, 1885.						
Girvan,	...	21·4	71·4	...	7·2	...
Inveraray,	...	20·0	60·0	20·0	...	...
Campbeltown,*	...	...	100·0	...	...	...
Loch Broom,	...	...	...	...	...	...
Stornoway,*	...	...	75·0	25·0	...	...
Wick,.	...	33·0	50·0	17·0	...	...
Lybster,	1·1	22·8	52·2	22·8	1·1	...
Helmsdale,	...	...	...	...	...	...
Cromarty,	...	...	...	...	...	...
Findhorn,*	...	...	100·0	...	...	...
Buckie,	...	...	33·3	55·5	11·1	...
Banff,	...	...	...	...	...	...
Fraserburgh,	...	14·0	50·0	36·0	...	...
Peterhead,	...	5·0	57·0	38·0	...	...
Aberdeen,	5·5	44·4	39·0	11·1	...	...
Stonehaven,	2·9	37·1	37·1	20·0	2·9	...
Montrose,	...	19·5	58·3	22·2	...	...
Anstruther,	...	14·3	35·7	50·0	...	...
Leith,	...	...	...	...	...	...
Berwick,	2·3	22·7	41·0	29·5	4·5	...
Orkney,*	25·0	...	75·0	...	...	...
Shetland,	...	9·1	27·3	63·6	...	...

* The number of fish included is too small to be a reliable indication of the natural condition.

The table brings out what we have already seen as to the greater variation among the winter than the summer herrings; the relatively smaller heads being found in more localities in winter than summer, and the relatively largest not being represented at all in the summer list. This of course must be quite distinguished from the relative size of the head among all the fish, as given in Table VI. Otherwise the preceding table gives us practically no indication of any special size of head being more prevalent in one locality than in another. It must be noted that the actual distinction between the figures in adjacent columns of the table indicates no great difference between the sizes; and, in fact, since the division into these classes is purely for convenience of general comparison, which would from the large number of minute variations be otherwise extremely difficult, many of the fish included in one column would require only a small fractional difference to shift them into the neighbouring column, nearer which they may really be than to others included under the same head. We must look, therefore, only for strongly marked distinctions, such, for instance, as seem to occur between the winter fish of Banff and Fraserburgh. These examples, however, are marked as unreliable, and in this respect, therefore, are of little or no value. The Banff specimens consisted of only two fish, from which it would be absurd to conclude that no intermediate forms were to be found there, as, in fact, we know they must be by the returns from the neighbouring districts. They are, however, included in the table as being of considerable interest otherwise, and having a bearing on the returns from other places. They are of special interest because they were caught at the same time and place, and demonstrate the presence in one and the same shoal of the widest extremes of those conditions in which we find the length of head of the herring. Those places which are distinguished in the table by having fish with one or other or both of the extremes of length of head are so widely separated and the circumstance that no such peculiarity is shown by herrings from neighbouring districts, even when so adjacent that some of the samples must have come almost from the same shoals, is evidence, I think, that this mere difference is insufficient to justify us in saying that these localities possess a different race of herrings from any or all of the others.

The percentages for 1884 and 1885, and which are combined in Table VIII., agree in general closely, but as showing the difficulties which are met with and the likelihood of falling into error by too narrow a view of the distinctions, the percentages according to head variation of the fish sent from Girvan (principally netted on the Ballantrae bank) in 1884 and 1885 are given below separately:—

Ratio of head length to body length.	·127 to ·138	·139 to ·150	·151 to ·162	·163 to ·174	·175 to ·186	·187 to ·198
Winter, 1884 .	1·2	13·1	40·5	33·3	9·5	2·4
Winter, 1885 .	...	1·6	17·7	45·1	34·0	1·6

From this there would appear to have been in 1885 a decrease in the shorter headed and a corresponding increase in the larger headed fish over 1884—a difference quite as marked as the previous table shows between distinct districts.

Position of Dorsal Fin.

The position of the dorsal fin has probably had more attention bestowed on it than any other character, with the purpose of discovering or demonstrating by its means some method of distinguishing the varieties, if there be such, of herrings from each other, as well as from the other members of the genus *Clupea.* Commonly the variation of this characteristic has been determined by the position of the first ray of the fin, the few exceptions being those where the fin generally is referred to as a whole, no special point in it being particularised.

The examination of a very few herrings discloses the fact that not only does the dorsal fin vary in position, but it also varies in basal length; consequently in limiting our inquiry to the position of the dorsal fin as expressed by the position of its first ray, we are mixing up two distinct characters, and the result is doubt as to the actual position of the fin. On this account my examination into the position of the dorsal fin has been made with regard to the centre of the fin—a separate examination being then made of the various lengths presented by the fin relatively to the body length. I have, however, also ascertained the variation in position of the first ray, and shall have to make some reference to it also.

In this investigation the position of the centre of the dorsal fin has been found with reference to two different measures of length, viz., its position relatively to the body alone (*i.e.*, the body length minus the head and tail lengths), and, secondly, to the total length of the fish from tip of closed lower jaw to tip of caudal fin.

The variation in position of the fin centre relatively to the body length runs from ·465 to ·540 in the examples of winter fish. Among the summer herrings the extent of variation is rather less, being from ·474 to ·540. A similar distinction, though small, has already been noted in respect to the length of head.

It is rather difficult to reconcile the varied results which the position of the dorsal fin gives us on winter and summer fish, mature and immature, and relative to the length of body only, and to the total length. Table IX. shows the range of variation divided into five classes, and a study of these shows that a much larger percentage of the summer herrings had the centre of the dorsal fin placed relatively far back than was the case with the winter fish.

TABLE IX. showing the percentage of Herrings arranged according to position of centre of dorsal fin relatively to length of body.

Range of Variation.		·465 to ·480	·481 to ·495	·496 to ·510	·511 to ·525	·526 to ·540
Mature Herrings	Winter	11·5	34·5	30·2	18·6	5·2
	Summer	2·7	15·8	32·6	41·8	7·1
Immature Herrings	Winter	32·6	42·8	24·6	...	...
	Summer	29·6	37·0	29·6	3·7	...

Tables X. and XII. show this more simply, where the position of the fin is indicated as 'before,' 'on,' and 'behind, the centre of body length.' Tables XI. and XIII. show the same with respect to the whole length, including head and tail.

TABLE (X.) showing percentage of Mature Herrings arranged according to position of centre of dorsal fin, relatively to centre of body length.

Relative Position.		Before Centre.	On Centre.	Behind Centre.
Percentage.	Winter	47·6	15·8	36·6
	Summer	23·2	6·8	70·0

TABLE (XI.) showing percentage of Mature Herrings arranged according to position of centre of dorsal fin, relatively to centre of total length.

Relative Position.		Before Centre.	On Centre.	Behind Centre.
Percentage.	Winter	31·4	14·3	54·3
	Summer	21·2	12·8	66·0

TABLE (XII.) showing percentage of Immature Herrings arranged as in Table X.

Relative Position.		Before Centre.	On Centre.	Behind Centre.
Percentage.	Winter	77·0	16·4	6·6
	Summer	66·6	3·7	29·6

TABLE (XIII.) showing percentage of Immature Herrings arranged as in Table XI.

Relative Position.		Before Centre.	On Centre.	Behind Centre.
Percentage.	Winter	56·0	18·6	25·4
	Summer	58·7	10·3	31·0

The small number falling on the centre is of course to be expected, there being included in it only those herrings which show the fin in that particular position, whereas the other divisions include the fish falling under all the other grades of variation, and also, of course, those so near the centre as only to differ from those centrally placed by $\frac{1}{500}$ of the length of body.

These tables show that a majority of the winter herrings, although not a large one, have the centre of the dorsal fin in front of the centre of the body; whereas among the summer herring a large percentage have it behind the centre. Tables X. and XI. cannot well be compared with each other, owing to the difference of dimension of the standard of comparison.

The length of the caudal fin behind the end of scales, although subject to the usual variations, may be said generally to be shorter than the head, this difference being much more pronounced among the winter fish. Hence we find that where the majority of fish have the dorsal fin behind the centre of the body length, as among those of summer, it may appear relatively to the whole length as not quite so far back; and, as a consequence, the percentage of fish with the fin behind the centre, relatively to total length, would be slightly decreased. (I use the word centre here as indicating a median position and not as an absolutely fixed point). As regards, however, the arrangement followed in Table XI., there will only be a slight difference from Table X., due to the slightly greater length of the heads over the caudal fins causing the centre of total length to be moved forward. Since among the winter herrings the majority have the

dorsal fin anterior to the centre of the body length (though not to such a decisive degree as its backward position appears among those of summer), yet, when taken relatively to the total length, its position in the majority of examples is posterior to that point; the explanation would appear to again lie in the fact that, in the latter case, the centre point will be brought forward, *i.e.*, the fin will apparently go back in position, and this will be strongly emphasised by the fact that most of these winter fish—a considerably larger proportion than of the summer—have the head longer than the caudal fin behind the scales. The greater change of position of the fin among the winter fish in the two tables than among those of summer will be partly also increased by the circumstance formerly noticed, that the head of the winter is rather larger than that of the summer herring. According to either table, however, there is a larger proportion of summer fish with the centre of the dorsal fin behind the body centre than of those of winter. It must be remembered, however, that so many fish of both winter and summer seasons cover the same ground of variation, that in itself this could only be trusted to as a means of distinguishing the one from the other in the case of a large number.

The tables of immature fish show us that among both the winter and summer herrings the fin centre is generally anterior to the centre of the body length and of the total length; this being much more pronounced among the immature herrings caught in winter than among those taken in summer. The head of the immature herring is relatively larger than that of the mature, for which reason the dorsal fin would appear further forward among them as relative to the total length, but we must notice also, in comparing these tables, that the winter immature fish were generally shorter than those caught in summer, in consequence of which the percentage of winter immatures with the dorsal fin in the most anterior position is likely to be greater than that of the summer immatures. It appears, however, that as the herring grows, the centre of the length of body comes forward, or in other words there is a greater increase in length between the centre of the dorsal fin and the head, than between that point and the tail.

An examination of the position of the first ray of the dorsal fin need not be entered into fully since the length of the fin, to be afterwards referred to, is the only condition of variation affecting its position beyond what is shown by its centre; but it may be noted that in general, as stated above for the centre, the first ray position covers, among the winter fish, a larger range of variation, especially in a forward direction, than does that of the summer fish, and as a consequence of this, the percentage of herrings with the fin anterior to the centre of body is much greater among the winter than among the summer fish.

Table XIV. scarcely requires explanation. It shows again the prevalence of the dorsal fin centre anterior to centre of body among the winter herrings. The division representing the most anterior fin position contains herrings from every locality. That indicating those with a backwardly placed fin contains fish from such widely separated districts,—as Girvan, Helmsdale, and Anstruther,—that we can scarcely on that ground alone be justified in altogether excluding the others without further corroborating proof.

The columns containing the results, as regards the centre of body, must not be read too strictly, but subject to the correction of the table of proportions, as, for instance, in the case of Lybster, where two-thirds of the herrings are shown as having the fin anteriorly placed. The real position of half of those that fall under this heading was really so close to the centre, that practically they might have been placed in that category, and would have shown a considerably different, perhaps truer, result. More-

TABLE (XIV.) showing percentage of Herrings from each Fishery District, arranged according to Relative Position of Centre of Dorsal Fin, and as 'before,' 'on,' 'behind, centre of body.'

Ratio of position.	Winter Herrings.					Summer Herrings					Winter Herrings.			Summer Herrings.		
	·465 to ·480	·481 to ·495	·496 to ·510.	·511 to ·525.	·526 to ·540.	.465 to ·480.	·481 to ·495.	·496 to ·510.	·511 to ·525.	·526 to ·540.	Before centre.	On centre.	Behind centre.	Before centre.	On centre.	Behind centre.
Girvan,	24·1	31·0	32·7	10·3	1·8	...	23·0	46·0	23·0	8·0	74·0	12·0	14·0	69·0	...	31·0
Inveraray,	...	...	...	...	...	...	...	40·0	40·0	20·0	...	...	...	...	40·0	60·0
Campbeltown,	...	...	...	...	...	...	33·3	33·3	33·3	...	...	...	...	66·6	...	33·3
Loch Broom,	...	50·0	50·0	...	...	...	...	...	...	...	50·0	50·0	...	...	...	...
Stornoway,	...	...	...	...	...	...	40·0	20·0	40·0	...	...	...	...	60·0	...	40·0
Wick,	13·8	41·4	31·0	13·8	...	8·0	20·0	16·0	56·0	...	62·0	24·2	13·8	40·0	...	60·0
Lybster,	33·3*	...	33·3*	33·3*	...	2·2	13·6	36·8	41·0	6·4	66·6	...	33·3	35·8	12·6	51·6
Helmsdale,	5·5	33·3	11·0	22·2	28·0	...	...	...	...	...	38·8	5·5	55·7	...	...	...
Cromarty,*	33·3	66·6	...	...	...	...	...	...	...	...	100·0	...	...	...	...	...
Findhorn,	13·3	26·6	20·0	26·7	13·3	...	...	...	100·0	...	46·6	13·4	40·0	...	...	100·0
Buckie,	16·1	32·2	26·0	16·1	9·6	25·0	33·3	25·0	8·3	8·3	54·9	12·9	32·2	66·8	16·6	16·6
Banff,*	50·0	...	...	50·0	...	...	...	...	...	...	50·0	...	50·0	...	...	...
Fraserburgh,	...	...	...	...	...	7·1	35·7	35·7	21·5	...	57·0	7·1	35·9	...	...	...
Peterhead,	10·0	10·0	40·0	40·0	...	4·8	19·0	33·3	28·5	14·3	50·0	10·0	40·0	52·4	4·8	42·8
Aberdeen,	7·7	46·2	38·4	7·7	...	...	5·3	21·0	57·9	15·8	61·5	30·8	7·7	21·0	...	79·0
Stonehaven,	15·0	55·0	10·0	20·0	...	...	10·2	28·2	59·0	2·6	75·0	5·0	20·0	33·2	5·2	61·6
Montrose,	12·5	12·5	50·0	25·0	...	...	12·5	25·0	57·5	5·0	50·0	25·0	25·0	27·5	2·5	70·0
Anstruther,	15·9	36·3	25·0	20·5	2·3	...	29·4	41·2	23·5	5·9	56·7	20·5	22·8	82·3	...	17·7
Berwick,	...	...	...	...	...	2·8	11·4	37·2	37·2	11·4	...	...	...	40·0	2·8	57·2
Shetland,	...	...	...	...	...	...	...	60·0	40·0	...	60·0	...	40·0	...	...	...

* Small samples.

over, the reading of the columns of summer fish will often show that where an entry under the heading 'before centre' seems to indicate a majority of fish with fins situated far forward, it may really contain many fish with the fins so near the centre, that they should properly be excluded from the former list. The figures in the table should be taken as approximately rather than absolutely correct. It does not seem possible to find any special law regulating the position of the dorsal fin among the summer herrings, so far as locality is concerned.

Position of Anal Fin.

The position of this fin may be considered in two ways, viz., its position on the body of the fish and its position with respect to the dorsal fin. Of course, a comparison of its position on the body with the position of the dorsal fin on the same will give in a general way an idea of its relation to the latter, but only an analysis of the measurements, fish by fish, will inform us to what extent its variation in position is dependent on that of the dorsal. While we may find the general position of the anal fin on the body, and compare it with the general results arrived at regarding the same. character in the case of the dorsal fin, we cannot, without a much more minute analysis of the case in every fish, ascertain how far any special peculiarity in one or the other may be common to both.

As I have already said, the commencement of the anal fin is close to the vent, and therefore, in finding the position of the first anal ray, we are also ascertaining the position of the vent.

Using what I have called the common scale for the indication of the ratio of any characteristic to the body length, we find that the position of the anal fin has apparently a very small variation—from 1·21 to 1·35; but taking as an index of variation the ratio which it bears to the body length in parts of that dimension, we find that it really extends, like the dorsal, over a considerable range—from ·735 to ·827.

Again, as with the other characters, we find these extremes are reached by a comparatively small number of herrings; a large majority have the fin within the limits—·752 to ·785. The winter fish vary rather more in the direction of a forwardly-placed fin than do the summer, viz., ·735 to ·813; while the summer fish have the advantage in the other direction, varying from ·740 to ·827.

Classifying as before, we get the following table of results:—

TABLE (XV.) showing Percentage of HERRINGS, arranged according to Position of first Ray of Anal Fin relatively to Length of Body (to end of scales).

Ratio of Position of Fin.		·735 to ·753.	·754 to ·772.	·773 to ·791.	·792 to ·810.	·811 to ·829.
Mature Fish.	Winter,	10·0	53·0	33·0	3·8	·2
	Summer,	2·0	19·0	46·7	30·5	1·8
Immature Fish.	Winter,	17·3	49·3	26·6	5·4	1·4
	Summer,	6·3	37·5	40·6	12·5	3·1

The table represents a similar result to that of Table IX. respecting the dorsal fin. It shows the same excess of percentage of summer herrings

TABLE (XVI.) showing Percentage of Mature Herrings from each Fishery District, arranged according to relative position of anal fin.

Ratio of Position of Fin.	Winter Herrings.					Summer Herrings.				
	·735 to ·753.	·754 to ·772.	·773 to ·791.	·792 to ·810.	·811 to ·829.	·735 to ·753.	·754 to ·772.	·773 to ·791.	·792 to ·810.	·811 to ·829.
Girvan,	7·6	49·6	36·5	6·3	...	...	28·7	64·3	7·0	...
Inveraray,	...	...	...	...	...	...	40·0	60·0	...	...
Campbeltown,*	...	...	...	...	...	...	20·0	80·0	...	...
Loch Broom,	11·1	66·6	22·2	...	...	...	...	...	...	...
Stornoway,	...	...	...	...	...	...	25·0	25·0	50·0	...
Wick,	2·3	68·2	29·5	...	...	...	29·2	45·8	25·0	...
Lybster,	...	25·0	...	50·0	25·0*	2·2	14·8	49·0	33·0	1·0
Helmsdale,	14·5	47·9	33·3	4·3	...	...	...	...	...	...
Cromarty,	...	33·3	66·6	...	...	...	...	...	...	...
Findhorn,	4·7	62·0	28·5	4·7	...	...	33·3	66·6*	...	...
Buckie,	14·6	52·4	26·8	4·9	1·3	...	20·0	50·0	30·0	...
Banff,*	...	50·0	50·0	...	...	...	...	...	...	...
Fraserburgh,	...	100·0*	...	...	...	...	21·4	42·8	35·8	...
Peterhead,	21·5	50·0	28·5	...	...	14·3	14·3	52·4	19·0	...
Aberdeen,	30·7	30·7	38·6	...	...	...	15·7	68·5	5·3	10·5
Stonehaven,	18·0	39·2	42·8	...	...	...	20·5	48·7	28·2	2·6
Montrose,	...	66·3	33·3	...	...	...	14·0	44·4	41·6	...
Anstruther,	16·7	55·0	28·3	...	...	5·9	29·4	35·3	29·4	...
Berwick,	...	...	...	...	...	5·7	...	37·2	54·3	2·8
Orkney,	...	...	...	...	...	...	...	50·0	50·0	...
Shetland,	...	...	...	...	...	...	20·0	40·0	20·0	20·0

* Small number of fish.

over the winter in regard to the backward position of the fin. It seems probable, too, from this comparison of the position of the dorsal and anal fins, that the latter holds among the fish of both seasons a similar position relatively to that of the former. This circumstance—that the anal fin holds, as a general rule, a more backward position on the summer herring than it does among those of winter—fairly entitles us, I think, to look upon the suggestion of the difference in relative position of the dorsal fin being distinctive of the fish of these seasons, as substantiated.

Table XVI. contains the percentage of fish arranged according to position of the anal fin, as found in the various fishery districts.

The fact that most of the fish are grouped in those columns which denote a relatively anterior position, rather than in the centre or towards the other extreme, is merely an indication that the range of variation beyond the common ground (second column for the winter herrings, third for the summer) is greater in extent, though more sparingly represented than is the variation towards a forward position.

Position of Pelvic Fin.

The position of this fin may, like that of the anal, be taken relatively to the total length of the fish, or to the position of the dorsal fin. The latter method will be reduced in value if it is considered in connection with the position of the first dorsal ray, for then we have the position of the pelvic made subservient to the variation in length of the dorsal fin, and consequently its position relatively either to the body or to the fin as a whole, is not accurately ascertained. If, however, we compare its position with that of the centre of the dorsal fin, we get a more accurate result. The position relatively to the centre of the dorsal fin will here be given, and, in addition, it will be classed under four divisions corresponding to the first, second, third, and fourth quarters of the dorsal fin, according to its position below these parts. These divisions, of course, are somewhat dependent on the length of the dorsal fin, but the anterior two combined, and the posterior pair taken as one, give the result of 'before' and 'behind' the centre.

The variation of the pelvic fin is found to extend from ·505 to ·599 on the body length to end of scales, an extent almost the same as that of the dorsal, which leads to the supposition that it follows the variability in position of that fin.

TABLE (XVII) showing Percentage of HERRINGS, arranged according to Position of the Pelvic relatively to the Dorsal Fin.

Divisions of Dorsal Fin.		First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.	Before Centre.	Under Centre.	Behind Centre.
Mature Herrings.	Winter,	27·4	66·6	6·0	0·	93·3	1·2	5·5
	Summer,	34·0	64·1	1·9	0·	97·5	·9	1·6
Immature Herrings.	Winter,	30·3	68·2	1·5	0·	97·0	1·5	1·5
	Summer,	31·7	65·8	2·5	0·	96·2	2·5	1·3

It appears that the summer and winter herrings agree in the position of this fin relatively to the dorsal, as do the immature with the mature;

which means that the pelvic fin of the winter herring is, in the majority of instances, more anteriorly placed than in the summer fish.

The pelvic fin of the young herring of about 30 mm. long is situated in front of the first dorsal ray, as in the sprat. By the time it has reached the stage of those being now dealt with, *i.e.*, from 170 to 240 mm. long, the fin has quite reached the condition found in the adult, and probably does so much younger, although my investigations do not enable me to say exactly when that occurs, except that it has passed behind the first ray by the time it is 60 mm. long.

Position of Pectoral Fin.

There seems to be little difference in the position of the pectoral fin on the summer and winter herrings, the winter having it if anything slightly further back than the summer fish. That is, the fish which have the pelvic fin furthest back have the pectoral furthest forward. The very small difference shown in the table between the two, however, scarcely warrants us in concluding this to be a general rule. The variation is from ·033 to ·99 in the winter fish, and from ·031 to ·104 in the summer.

TABLE (XVIII.) showing Percentage of HERRINGS arranged according to Position of Pectoral Fin relatively to Body Length.

Ratio of Fin Position.	·031 to ·044	·045 to ·058	·059 to ·072	·073 to ·086	·087 to ·100
Winter, ...	5·9	20·4	37·7	26·5	9·5
Summer, . . .	10·8	32·7	33·3	19·4	3·8

Basal Length of Dorsal and Anal Fins.

The variation in the dorsal fin length, relatively to the length of fish to end of scales, extends from ·104 to ·156 on the winter herrings, and from ·106 to ·158 among the summer fish.

TABLE (XIX.) showing Percentage of HERRINGS arranged according to Basal Length of Dorsal and Anal Fins relatively to Body Length (to end of scales).

Ratio of Fin Length.		·083 to ·097	·098 to ·112	.113 to ·127	·128 to ·142	·143 to ·158
Dorsal Fin	Winter, .	...	5·7	57·6	29·2	7·5
	Summer, .	...	2·9	48·4	43·7	5·0
Anal Fin	Winter, .	2·4	49·0	43·8	4·8	...
	Summer, .	10·7	50·8	34·3	4·2	...

The anal fin varies in length from ·087 to ·140 in the winter fish, and from ·083 to ·133 in those of summer. There appears to be no special predominance, as regards either fin, of any particular length over another; nor is there any special distinction between the mature and immature herrings; but it will be seen that the majority of the winter fish have a narrower range of variation in the dorsal fin length than those of summer.

The divisions in the table have been arranged to suit both dorsal and anal fins, and facilitate comparison, consequently the percentage of fish with the shorter class of dorsal fin is rather smaller than it should be, in fact the whole dorsal fin percentage is very slightly and unimportantly exaggerated towards the larger extreme of fin length.

Although so large a percentage of both summer and winter herrings have the dorsal and anal fin lengths in the same columns of the table, it must not be supposed that the combination on one fish of dorsal and anal fins of the same length is common. On the contrary, the dorsal fin is generally longer than the anal. Of the winter herrings examined only 7·5 per cent. had the anal fin longer than the dorsal, and scarcely 5 per cent. had it of the same length; of this quantity 8 per cent. were immature fish. Among the summer fish the percentage was less, only 1·7 per cent. having the fin longer, while in 6·5 per cent. the fins were equal; of this quantity 5 per cent. were immature.

It ought to be noticed that all these figures relate to the proportional length of the fin. The difference between the condition in each season, though very small, was slightly in favour of the winter fish having relatively a shorter dorsal and a longer anal fin than the summer. The average of the absolute length of both dorsal and anal fins was greater among the winter than among the summer herring—a circumstance possibly due only to the rather larger size of the winter fish.

Fin Rays.

The number of rays in the dorsal and anal fins does not seem much to affect their basal lengths. The rays of the dorsal fin of the mature summer herring vary in number from 16 to 20, and in the anal fin from 14 to 19. My observations of the number of rays in the fins of the winter herrings are as yet scarcely sufficiently extensive to be altogether trustworthy as an index of the normal condition among the fish of that season, but so far as they go they give no indication of any special distinction in this respect between the herrings of winter and summer.

Tables XX. and XXI. contain the percentages of summer fish, arranged according to the number of rays in the dorsal and anal fins, and to the absolute length of the fins.

The pelvic fin is very constant in the number of its rays, being generally composed of nine. Where a variation from this number does exist, it is in many cases a one-sided abnormality. The following are the percentages of the herrings examined according to the number of the pelvic fin rays:—

With	6	rays	in one fin,	7 rays in the other,	0·28	per cent.
,,	8	,,	in both fins,	. . . .	2·00	,,
,,	8	,,	in one fin,	9 rays in the other,	0·28	,,
,,	9	,,	in both fins,	. . . .	96·3	,,
,,	9	,,	in one fin,	10 rays in the other,	0·57	,,
,,	10	,,	in both fins,	. . . .	0·57	,,
					100·00	

TABLE (XX.) of Number of Rays and Basal Lengths of Dorsal Fin.

	Basal Length of Fin in mm.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	Total Percentage according to Number of Rays.
Number of Rays.	16	...	...	...	...	...	...	...	·29	...	·58	...	...	...	...	...	·29	...	...	1·16
	17	·29	·58	·58	2·58	2·86	2·86	7·73	4·58	4·58	4·3	2·86	2·86	·86	·86	·29	...	...	...	38·67
	18	..	·29	·29	1·15	1·72	3·72	5·15	11·45	8·0	8·9	6·0	4·0	1·44	1·72	·86	·29	·29	·29	55·56
	19	...	...	...	...	·29	...	...	·58	1·15	1·15	·58	·58	...	...	...	...	...	...	4·33
	20	...	...	...	...	...	...	·29	...	...	...	...	...	...	...	...	...	...	...	·29
Total Percentage according to Fin Lengths, . .		·29	·87	·87	3·73	4·87	6·58	13·17	16·9	13·73	14·93	9·44	7·44	2·3	2·58	1·15	·58	·29	·29	

TABLE (XXI.) of Number of Rays and Basal Lengths of Anal Fin.

	Basal Length of Fin in mm.	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Total Percentage according to Number of Rays.
Number of Rays.	14	...	...	·6	...	·3	·3	...	...	...	...	...	...	...	...	...	...	...	...	...	1·2
	15	...	·3	·3	·87	2·61	1·74	·87	1·74	·3	·87	·6	...	·3	...	...	...	...	...	...	10·5
	16	...	·6	·87	1·45	6·6	8·14	6·4	5·22	2·9	3·20	2·61	·6	·87	·3	...	...	...	...	...	39·76
	17	·3	...	1·74	1·74	2·32	6·1	4·36	5·5	2·9	7·55	2·0	3·2	1·16	·3	...	·3	·3	...	·3	40·07
	18	...	...	...	·3	·3	·87	·87	1·74	1·16	·87	·87	·6	·3	...	...	...	...	...	...	7·88
	19	...	...	...	...	...	...	...	·3	...	...	·3	...	...	...	...	...	...	...	...	·6
Total Percentage according to Fin Lengths, . .		·3	·9	3·51	4·36	12·13	17·15	12·50	14·50	7·26	12·49	6·38	4·4	2·63	·6	...	·3	·3	...	·3	

The number of rays in the pectoral fin varies from 15 to 19; the percentages being—

With 15 rays,	·9 per cent.
„ 16 „	17·6 „
„ 17 „	56·0 „
„ 18 „	22·7 „
„ 19 „	2·8 „
	100·0

There seems to be a slight tendency towards an increase in the number of fin rays (always excepting those of the pelvic and caudal fins) as the herring grows larger, for there is seldom an immature herring found with the higher number of rays nor a large fish with the lower, which seems to be due to the fact that in the immature and younger fish, that which will eventually become the first ray is so small as readily to escape notice, often indeed being hidden by the scales.

The caudal fin consists of 19 rays, excluding the small imperfect rays on the external part of the root of the fin, and counting only the two unsplit rays which form the dorsal and ventral edge of the fin proper and the rays included between them. These caudal-fin rays are not equally distributed between the upper and lower lobes of the fin. There is no median ray, and the real centre line of the fin * is formed by the space—rather wider than between the others—lying between the tenth and eleventh rays, there being thus 10 rays in the upper lobe and 9 in the lower. This is true for the winter and summer fish. The variations to be recorded are very few.

With 11	rays in upper lobe,	9	in lower,	·3	per cent.
„ 10	„ „	9	„	98·0	„
„ 9	„ „	9	„	·85	„
„ 9	„ „	8	„	·85	„

Keeled Scales.

My observations on the number of these are as yet too few to afford a fair comparison between the summer and winter fish. So far as I have gone I have not been able to detect such a difference between the respective numbers of these as Heincke has done in the Baltic herring, and which enables him to quote them as a racial distinction.

These scales may be divided into three sets—partly from their difference in form, partly from their position. At the anterior end of the body of the herring is a series of small, narrow, oval-shaped scales, with only a slight keel, and no diverging rays. These form the first set. Behind these small scales come the ordinary keeled scales, all provided with the diverging rays which pass a short way up the sides of the abdomen. These scales are continuous as far back as the vent, and may be divided into those anterior and those posterior to the pelvic fin, the last scale of the former set having two or three modified rays, apparently the result of the combination of more than one scale. The total number of the three sets varied from 41 to 46 in the herrings examined,

14·3	per cent. of the herrings having	41 scales.
42·7	„ „ „	42 „
25·7	„ „ „	43 „
11·4	„ „ „	44 „
2·9	„ „ „	45 „
2·9	„ „ „	46 „

The average number being 42·5.

* Looking at the external symmetrical condition of the fin and disregarding the arrangement of the rays with respect to the urostylar bone.

The first series of scales varied in number from 8 to 11, the average being 9·2. The second series varied from 18 to 20, with an average of 18·7, the majority of the fish having 19 scales. The third series varied from 13 to 17; the average 14·5. The various numbers represented in each season form several combinations with the others, the commonest being 9, 19, 14 = 42; but it seems doubtful whether any racial distinction will be discovered in respect to this characteristic among the Scottish herring.

Reproductive Organs.

Besides subjecting to examination the external characteristics of the Scottish herrings, the condition of the reproductive organs was taken note of, both for the purpose of ascertaining the sex of the fish and whether any distinction could be drawn between male and female in other respects, and also whether any light might thereby be thrown on the subject of variability.

No difference in regard to size of fish, size of head, &c., was discovered between the male and female herring. Both sexes were represented in all the grades of general size, and both showed the same number and extent of variations. Nor was there an appreciable difference in the number of males and females caught; the percentage in the samples examined (1100) being—of summer fish, 50·8 per cent. females, 49·2 per cent. males; of winter fish, 52·5 per cent. males, 47·5 per cent. females.

A little experience permits of a very fair determination being made by naked eye examination only, of the condition of ripeness of the generative products, as more accurately ascertained by microscopical examination.

For convenience in classifying the herrings according to their sexual condition, I divided them into the following stages of maturity:—(1) Ripe—that is, either just commenced to spawn or where the appearance and size of the ova, as well as the ease with which it could be expressed (and this cannot be done in the fresh fish without exaggerated pressure, unless it is fully ripe), showed that spawning would have taken place almost immediately. (2) Three-quarters ripe, when the ovary filled the whole abdomen completely, but the ova were smaller and not so clear as when fully ripe, and only a few had yet passed into the oviduct, or even into the undivided duct-like portion of the ovary. (3) Half-ripe, where the ovary was fairly large, but not so large as to appreciably distend the abdomen, in which the ova were visibly smaller and less ripe than in the last stage, and were still firmly adherent to the ovarian septa. (4) Quarter-ripe, where the ovary was small in bulk, only about one-half to three-quarters the length of the abdominal cavity, the ova not half the size of ripe eggs, and solid and opaque-looking in mass. (5) Spent, when the ova were fully extruded, and the ovary presented a slack and partially corrugated appearance; or quarter, half, three-quarter spent, according to whether the ova had been to that extent extruded before capture. (6) Immature, with small, red, gelatinous-looking ovary, the ova indistinguishable by the naked eye. A similar distinction was made in the case of the male fish, although the absence of the naked-eye evidence of the state of development of the spermatozoa made it rather less certain. Those herrings with the ovary in an earlier stage than that of quarter-ripe, and in which the ova were just visible, and the ovary little larger than that of the wholly immature herring, were included with the more mature fish, for the purpose of defining the extreme characteristics, but were specially marked as probably having reached sexual maturity for the first time; my reasons for coming to which conclusion have already been stated.

TABLE (XXII.) showing Percentage per Month of Herrings (total number, 1100) according to their Sexual Maturity.

Sexual Condition.	Jan.	Feb.	March	April.	May.	June.	July.	Aug.	Sept.	Oct. Nov. Dec.
Ripe............	12·8	37·1	57·6	0	0	0	26·8	42·8	66·6	Percentage not ascertained, but ripe, $\frac{3}{4}$, and $\frac{1}{2}$ ripe received from South-West Coast.
$\frac{3}{4}$ and $\frac{1}{2}$ ripe......	70·5	51·2	20·6	13·0	5·0	7·0	38·8	23·7	3·6	
$\frac{1}{4}$ ripe............	14·4	6·9	8·8	27·0	32·1	44·0	24·0	14·3	1·8	
Partially or wholly spent.	2·3	4·8	13·0	60·0	62·9	49·0	10·4	19·2	28·0	

The fully-ripe fish are probably understated in the table, because most of the actually spawning fish are unlikely (since herrings appear to spawn at the bottom*) to be within reach of the nets.

The ripe and three-quarter ripe January herrings came from Girvan, Loch Broom, and all the East Coast districts ; in February, from Girvan, Loch Broom, and all the East Coast districts except Berwick ;† in March as in January ; in April, from Campbeltown and Stornoway ; in May, from Stonehaven ; in June, from Inveraray, Stornoway, and Wick ; in July, from Girvan, Inveraray, and the whole East Coast ; in August and September, from the whole East Coast ; in October and November, from the South-West Coast (including Loch Fyne) ; and in December, from Stonehaven and Dundee. The dates are those in which the fish procured for this investigation were caught, and are typical of the spawning seasons ; but the exclusion of localities from some of the months does not mean that no such herrings were to be found there, but only that none reached me, and probably, therefore, there was little or no fishing at these places at the time.

The spawning, then, of the herring on the Scottish coasts alone, may be said, as previously pointed out by Ewart, to proceed during every month in the year ; for in April, May, and June fully-ripe fish are to be procured, although it so happens that none reached my hands during that period. Although there are two principal spawning periods, which may generally be called the winter and summer periods,‡ yet spawning to a very considerable extent is going on for ten months of the year—October and November on the East Coast, and April and May, being the principal 'off' seasons. It is very probable that were the means taken many more spawning fish would be caught in these months also.

The months of April, May, June, and the first few days of July are not only poor in the supply of nearly or fully ripe herrings, which to a certain extent is probably due to the regular fishing not being prosecuted, but are notable on account of the large percentage of herrings from such fishing as there is, consisting of immature fish (of course I exclude, in making this remark, the immature herrings caught by specially small-meshed nets). The large percentage of spents found in the table under these months were really few in number, and only hold a high position in the table because

* See Ewart's 'Observations on the Spawning of the Herring.'—Report of the Fishery Board for Scotland. 1883.

† Day ('Fishes of Great Britain') mentions spawning herrings being found in January at Wick and in the Moray Firth, but in almost the next sentence gives the extreme dates for the English and Scottish coasts, from Shetland to the North Foreland, as 'from the latter end of May to December.' Yet one of the principal spawning seasons on the East Coast of Scotland is January and February.

‡ I have preferred winter and summer to autumn and spring, because, though part of both these latter seasons are included in the principal spawning periods, the season of least spawning falls in them rather than in the others.

little else but immatures were being caught then, and these latter are not included in the percentages.

It is difficult to decide from the condition of the captured fish whether the spawning process in the herring is very short—a matter of hours, or a day or two at most—or whether it is prolonged over several days, or even passes into weeks. The presence of partially-spent fish would seem to show that it is not a short and single performance. But the fish in this condition are not so numerous as the spent fish which probably become more active, perhaps in the search for food, after the spawning process is entirely finished.* If spawning was a prolonged process, it is likely we would get many more in the partially-spent condition. If it were a matter of only a few hours, it is unlikely that we would get any except by the seine-trawl; yet the majority of my specimens came from offshore fishings during the summer months. Expressing the ova and milt by hand is but a rough test of what is likely to occur under natural conditions. I have found that with fully-ripe herrings about three-fourths of the ova or milt can be expressed; yet microscopic examination in these cases shows all the ova apparently equally ripe, not only towards the distal portion of the ovary, but also in its deeper chambers. It seems almost certain that the deposition of the roe is not a very prolonged process, and it probably only occupies a few days, during which most of the spawning fish are moderately quiescent. So far as concerns the spawning processes, the appearance of the reproductive organs, &c. suggests no difference between the winter and summer herring, except that the number of spent fish got in the summer fishing is rather greater relatively to the whole catch than is the case in winter, perhaps to be explained by nearly all my winter specimens being got in inshore waters, from which they may retreat more readily and quickly after spawning than they do from the more distant, deeper summer fishing-grounds.

A condition to be found in the spent fish raises the question of whether the herring spawns once or twice a year. If our winter and summer herring turn out to be distinct races, the question of double spawning scarcely needs to be considered, and our knowledge of the spawning habits of other fish would lead to the supposition that they only spawn once in the year. I reserve some observations on this matter for fuller investigation, but the condition referred to above may be mentioned, being one which may indicate a double spawning, or, as I think more probable, shows that the development of the ova within the ovary is very much slower in its earlier stages than in its later. In newly spent—even in not wholly spent—fish there is often to be seen a large number of small ova. It is not an uncommon occurrence to find in what may fairly be called a fully spent fish a few full-sized and fully-ripe ova still unshed. I have found as few as twelve, as many as eighty, scattered through the ovary,† mostly

* The general opinion about the feeding of the herring supports this statement, but I have considerable doubt as to the correctness of the belief that the spawning fish do not feed, or feed little, and that the spent do so to a much larger extent. The observation casually made when examining the reproductive organs of a large number of fish leads to the conclusion that the prevalence of this habit, judging by the condition presented by the stomach alone, is somewhat underestimated, for an examination of the lower part of the intestine, in six or seven cases out of ten, gives evidence that food, generally recognisable as different species of crustacea, must very lately have been consumed, and there do not appear to be more spent fish with food in their stomachs than of ripe fish.

† Considering the number of eggs ordinarily present in the herring this number is insignificant. Day gives 10,000 to 30,000 as the number of eggs in the herring. This is a fair statement, but I think slightly below the average, for of a number of fish whose roe I have examined I find the highest reaches 48,000 ova. About one-third had between 30,000 and 40,000, and there were far fewer with 10,000 to 20,000 ; the

separated from the ovarian septa and on their way to the exterior, while there were also present, and scattered thickly throughout the ovary, immense numbers of small ova which were certainly not likely to be shed for many weeks, probably not for some months. I am not referring here to the evidence of microscopic examination, but to ova which were sufficiently developed to be readily seen by the naked eye. There is nothing extraordinary in finding ova of such different stages of development as this where the animal deposits its eggs gradually and where ova are found in various intermediate conditions, but all present at one time; but in the case of the herring we have a fish spawning in a very limited period of time, and presumably only once a year, with ova which will be ripe about twelve months later, and yet are already fairly well developed before it has completed its present spawning. The circumstance that such large numbers of herring with ova only quarter or half ripe are caught during the principal spawning seasons points to the conclusion that these fish will spawn during the following month or two at most. Between what I have called quarter-ripe and the condition which I have been describing in the spent fish there is not much difference, so we must conclude that if these herrings are not to spawn again for a year, the ova develops very little during about nine months of that time. These observations were made on summer fish, but when examining the winter specimens my attention had not been attracted by this condition, and very probably it had been overlooked.

The size of the egg found in the ripe fish is of importance especially with regard to the question of variety among the herrings. Kupffer has found the ripe eggs of more than one size in the Baltic herrings, from ·92 to 1 mm. in diameter, while Boeck puts that of the North Sea herring at 1·5 mm. I have measured the eggs of several of the Scottish East Coast herrings and have found them vary slightly in size in the same fish, from 1·27 mm. to 1·42 mm. diameter; ova of these sizes were found in herrings of 230 and 240 mm. length (about 265 and 275 mm. total length). The commonest size was 1·27 diameter, but the larger and intermediate sizes were found together in the same spawning fish. In fish of about 215 mm. length the diameter of the ripe egg varied from ·94 mm. to 1 mm. In all cases the eggs were fully ripe, being taken from spawning fish, and were measured before the inception of water. None of the eggs were found so large as those mentioned by Boeck, and were rather larger than Kupffer's, but the point of importance here is the fact that the ova of the herring showed an increase in their average size corresponding to increase in size of the fish.* This month (February) herring have reached me from Ardrishaig which measure only 165 to 170 mm. long (190 to 200 mm. total length), being samples of the ordinary takes with seine net in upper Loch Fyne.† Some of these small herrings had fully ripe roe or milt, others half ripe, and others of the same size were in

usual number seems to lie between 20,000 and 35,000. Prof. Huxley (*Nature*, April, 1881) considers 30,000 eggs an over estimate due to forgetfulness that the ovary consists of an extensive vascular network, and that a vast number of eggs remain immature and unshed. In the herring just commencing to spawn, however, these latter are so minute and little developed as scarcely to affect the question. But my calculations were made with due allowance for both these objections.

* The average of many measurements of spermatozoa shows that they also were larger than those of the Baltic herring, being ·0033 mm. in head length, and having a filament of ·066 mm. Kupffer's measurements only give ·0025 mm. for head length, the tail being ·062 to ·075 mm.

† Ljungman states having received herrings of only 100 mm. in length (the size of a sprat), full and ready to spawn. Of about 3000 young herrings which I have examined during the last year or two, the smallest in which I have found ripe or nearly mature ova measured 185 mm. total length (7¼ inches), none less than this length showing the slightest approach towards this condition.

such an immature condition as to make it all but certain that they could not spawn for months, if not for a year. These small fish were caught at the same time and place, and it seems extremely probable that they were fish of the same age just as they were of the same size and appearance. It seems to me, then, that the variable size both of the spawning herring as well as of their ova probably has a considerable effect on the ultimate size of their progeny, but we can scarcely institute a special case of variety on these grounds alone, if the fish have every other characteristic in common with the larger herring.

Without a more critical examination than has yet been made, it would be unwise to speak definitely on the question of variety among the herrings of our coasts. The only evidence as yet found from the present investigation in favour of such a distinction between the summer and winter herrings, consists in the more posterior position of the dorsal, pelvic, and anal fins, the doubtfully smaller head, and the slightly lesser size of the summer herrings.

We have seen that the fishing in winter is generally prosecuted with a larger meshed net than is in use in summer. Hence the rather smaller size of the summer herring as we find it may be accounted for. But we can scarcely so account for the difference in the other characters. If the herrings caught in summer are smaller only on account of the smaller mesh of the nets employed to take them, and we therefore conclude that there are equally large fish in summer as in winter, and that these small fish are merely younger members of the same race, we ought in such case to expect them to have a relative length of head intermediate to that possessed by the immature and large herrings, that is, a head relatively longer than that of the larger winter fish; but although the difference is very little, such as it is, it is the other way. Again, we have found that the summer herrings have the dorsal and anal fins situated further back on the body than those of the winter. The immature fish have these fins relatively far forward, so that if the smaller ripe summer fish are simply young fish we would expect to find their fins at least as far forward as the others. On the whole, the examination of these characteristics in our Scottish herrings, so far as this preliminary and general investigation is to be depended on, seems to point to the conclusion that a certain difference does exist between the majority of the summer herring and those of the winter. There remains, however, the disturbing fact that examples of all the extremes of all the variations are represented among the herrings of both seasons. Of more importance still is the fact that what may be called the commonest ground of variation found in the winter herring is not only in proximity to, but overlaps largely the commonest ground of variation among the summer fish. All the variations, too, are found not only in fish frequenting the same place and in the same season, but even in the same shoals, and it does not seem possible to avoid the conclusion that there must be much interbreeding between the possessors of these varying characteristics. Whether the smaller ripe fish are fully grown or not, it is tolerably certain that many varieties of all kinds must result from the interbreeding of these with larger fish, and with all the intermediate forms; and this is likely to be more pronounced among fish spawning *en masse* like the herring, and subject to the general conditions of fertilisation among fish, viz., that it is external, and that the ova of one and the same herring are subject to and according to observations, almost certain to be fertilised by several males.

While suggesting, therefore, that there is a certain distinction between our summer and winter herrings, I am indisposed to consider the matter as conclusively proved without the facts being submitted to a more minute

analysis. I feel safer in declaring that there is not a 'racial' distinction between the herrings frequenting the different localities on our coasts. Dr Heincke divides the Baltic herring into two varieties, and each of these into spring and autumn varieties. While then we have some justification in supposing the latter to be the condition of our herrings, we have no evidence whatever in favour of the former being applicable to them.

APPENDIX F.—No. V.

ON THE NATURE OF THAMES AND FORTH WHITEBAIT.

By J. C Ewart, M.D., and J. Duncan Matthews.

Within the last few years it has become more common to hear doubts expressed as to whether the small fish sold so extensively in some of our markets, and known as 'Whitebait,' may be considered as forming a distinct species of the genus *Clupea.* Yarrell (confirmed later by Couch) called the whitebait *Clupea alba;* Valenciennes, forming a new genus, named it *Rogenia alba;* and Donavan supposed them to be the fry of the shad. Pennant suggested that they were the fry of bleak, deciding that they could not be sprats or shad, as these had eight branchiostegal rays, whereas the whitebait had only three. If this statement of Pennant's was correct, the whitebait examined by him cannot have been the same as that of the present time, which certainly have the typical number of branchiostegal rays found in the herring and sprat. It is probable, however, that Pennant had counted only the three flattened and easily seen external rays, overlooking the others, which in the very small fish are extremely delicate and not readily made out.

Among later writers the fact that they were merely the fry of one or more species has been generally asserted. Günther states that they are the young of herrings, and he found this to be the case with Yarrell's examples preserved in the British Museum. Saville Kent says that whitebait 1 to 1½ inches long were reared in the Brighton and Manchester Aquaria until they reached the size of young herrings, while Day, after examination of several samples, decided that the London whitebait consisted of the fry of both herrings and sprats; the result of his examination of a sample of 138 whitebait in May and June showing a percentage of young herrings and sprats of 90 and 10 respectively, a sample of 46 in August giving 21 herrings and 20 sprats, and an October sample consisting of nothing but young herrings. More lately the whitebait has been included under the old title of *Clupea alba* as a distinct species in the 'Handbook to the Aquarium, South Kensington,' issued by authority of the National Fish Culture Association.

A further and more extensive examination of the whitebait seemed therefore desirable to confirm or refute these conclusions, and especially by the examination of samples, consisting of larger numbers than hitherto, and procured during the whole of the principal fishing seasons, to settle whether whitebait varies at different seasons. The following are the results of such an examination of the whitebait sold in the London and Edinburgh markets in 1885 and 1886.

Of the London whitebait the examination during the month of February of samples amounting to 1400 specimens, showed that these were composed of 93 per cent. of young sprats and 7 per cent. of young

herrings, some of the herrings being under 2 inches in length and only partially scaled, while the sprats measured from 2 to 3 inches in length. During March 1200 specimens were examined, 95 per cent. being sprats 2 to $2\frac{1}{2}$ inches long, and 5 per cent. herrings, some of which reached a length of nearly 4 inches.

During April and May the percentage of herrings increased steadily, the 800 specimens examined in April consisting of 86 per cent. of sprats of an average size of 2 inches, and 14 per cent. of herrings, 12 per cent. of the herrings were less than $1\frac{1}{2}$ inches in length, with only the keeled scales developed. Of the 600 May specimens 70 per cent. were $2\frac{1}{2}$ inch sprats and 30 per cent. were young herrings, of the latter 40 per cent. were 2 inches long and completely scaled, while the remainder were $1\frac{1}{2}$ to $1\frac{3}{4}$ inches long and only partly scaled. Of 800 specimens examined in June 87 per cent. were herrings and 13 per cent. were sprats. Of the herrings 60 per cent. were fully scaled and from 2 to $2\frac{1}{4}$ inches long, while 40 per cent. were from 1 to $1\frac{1}{2}$ inches long, and either partially scaled or entirely scaleless. The sprats were from 1 to $2\frac{1}{4}$ inches long, the smaller having no scales or only keeled ones. Of 600 specimens in July, 75 per cent. were herrings, 25 per cent. sprats; the herrings varying from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches in length, 80 per cent. being less than 2 inches. Of the sprats 8 per cent. were under $1\frac{1}{4}$ inches in length and destitute of scales.

Five hundred specimens of August whitebait consisted of 52 per cent. of herrings 2 to 3 inches, and 48 per cent. of sprats 1 to $1\frac{1}{2}$ inches long. The number of small scaleless sprats gradually increased during the month, until 90 per cent. of the samples consisted of these.

The specimens of whitebait procured in Edinburgh were caught in the Firth of Forth, generally between Alloa and Kincardine. The fishing here is conducted principally during the winter months, and the takes are subject to very little variation as regards the kind of fish of which they consist, the examination of 2600 specimens of whitebait procured in samples of about 200 each during December, January, and February, being made up almost entirely (over $99\frac{1}{2}$ per cent.) of young sprats, measuring from $1\frac{3}{8}$ to $2\frac{3}{4}$ inches in length, over 70 per cent. of them being from 2 to $2\frac{1}{4}$ inches. The half-dozen herrings among these measured $1\frac{1}{2}$ inches.

It must be noted that this examination entirely excluded fish taken in the ordinary sprat fishery, which is also prosecuted at this season, and which consists of both sprats and herrings, which are generally over 3 inches in length.

In both the London and Edinburgh samples of whitebait a number, about 1 per cent., of small fish and other forms were found, but these were omitted in the above enumeration. Among the London specimens were found gobies (*Gobius ruthensparri*), sand launces (*ammodytes fobicanus*) shrimps, beroe, &c., and among the Firth of Forth specimens an example of *Gobius ruthensparri.*

It seems certain, then, that what are known as whitebait consist almost entirely and at all seasons of young sprats and young herrings, which vary in size and in the relative quantity of each according to the season of the year. While these two species are found in common at all seasons it is evident from the above returns that (if the years 1885–86 may be considered typical of the usual condition) of the fish composing the shoals in the winter and spring months, the sprats largely preponderate.

From the Firth of Forth winter fishery the herrings are practically absent, and in the London whitebait they are present only to the small extent of about 6 per cent. As the season advances, however, the number of young herrings increase, reaching at the end of May and during June over 80 per cent. of the shoals, while in July their numbers slightly

decrease. In August they form about one half of the shoals, and are considerably larger than in the two previous months.

The winter and spring sprats were about one-third to one-half grown. In June, July, and August, however, they were much smaller, and evidently developed from a later spawning, which would be in accordance with the spawning season suggested by the occurrence of ripe sprats from such widely separated localities as Girvan, Stonehaven, the Firth of Forth, and the Moray Firth, recorded in the Report of the Scottish Fishery Board for 1883, the winter sprats being probably six to eight months old.

Most of the young herring would appear to be developed from spawn deposited during the spring months.

There is not much difficulty in distinguishing a sprat from a herring by the external characters only, when the fish are above 2 inches long, but it becomes a difficult matter below that length. One of the most notable differences between the species, when more than 3 inches long, viz., the relative position of the dorsal and pelvic fins, is at the earlier stage of no value, the pelvic fin of the very young herring being commonly, like the sprats, anterior to the dorsal. One of the distinctions between these fish, first pointed out by Heincke, viz., that a line from the base of the pectoral fin and passing exactly across the lowest point of the operculum, will pass through or over the eye in the herring, but beneath the eye and through the snout of the sprat, is in these young fish generally of value, but the test requires to be applied with an exactitude inapplicable to a large number.

The possession by the herring of 9 rays in the pelvic fin and of 7 by the sprat is also a sound test, but difficult of application, on account of the soft character of the fin, the liability of the rays to split the difficulty of separating them as well as the injury sustained by crushing in the netted fish.

The best test undoubtedly is the number of vertebræ which in all the cases examined varied (as in the adults) from 47 to 49 in the sprats, and from 56 to 58 in the herrings, although these also required more than one enumeration in the case of the very small examples even with a lens. Experience in examination of these small fish adds some further evidence towards their correct identification in the number of pyloric cœca, the pigmentation, shape of the head, &c., and with ordinary care there seems to be no difficulty in absolutely deciding, not only their identity with herrings and sprats, but also their distinction from each other.

APPENDIX F.—No. VI.

PRELIMINARY REPORTS ON THE FOOD OF FISHES.

Introduction.

With a view of obtaining information as to the food of our more important food-fishes, a large amount of material has been examined during the last two years. This has chiefly been supplied by the officers of the Board, who have received from time to time the necessary instructions for the collection and preservation of specimens. In the present inquiry our attention has been mainly directed to a study of the food-

supply of the herring, cod, and haddock, and although that of other forms has been catalogued when information has been received, the present Reports are confined to the three species named.

The statistics supplied have necessarily been confined to the period during which each species has been captured in the various districts, and the information on the food of the cod and haddock has mainly been obtained from an examination of specimens brought in by the line fishermen.

As a rule fish take little or no food during the spawning period, and although this is not an invariable rule, there is no doubt that the period of rapid growth during which most food is taken is prior to each spawning season. For this reason a knowledge of the food taken throughout the year by the more migratory forms of food-fishes cannot be accurately ascertained from an examination of those caught in the in-shore waters.

Our knowledge of the variety of food taken by each species *throughout the year* is thus far from being complete for any one district. In the reports devoted to the cod and the haddock particularly it will be seen that there are several months during which no information has been obtained. It is hoped that by more extended observation, especially by a more thorough examination of the fish brought in by steam trawlers, these blanks may soon be filled in.

With the exception of observations made at Tarbert (Loch Fyne) during the summer, our information of the food of the herring is entirely limited to material preserved in spirit. The stomachs have been preserved whole by the Fishery officers and sent in to the Central Laboratory for examination. For many reasons this is not the most satisfactory method, but it is not always possible to examine fresh material. Arrangements have been made by which it is expected that these difficulties will be overcome in the future. The food of the cod and haddock has been studied from preserved material and also in the fresh state. In the latter case stomachs have been examined by the Fishery officers when the fish were landed, and a list of their contents transmitted to the Central Laboratory.

Much valuable information has already been supplied by Professor M'Intosh and others on the various marine forms which are utilised by fishes as food. It is not, however, our object to give a detailed account of every species which is known to have occurred in the stomach of a cod, a haddock, or a herring. It matters little to the present inquiry whether there should be one species more or less. What we want to know now is, what animals form the natural and regular food-supply of our more important fishes, and how far these vary with the district and season of the year. Accurate information on these points should teach us much that is of vital importance to our Fisheries as a commercial industry. Such information is only to be obtained by the collection of elaborate statistics from all parts of the coast, and extended over a number of years. The accompanying Reports are a first contribution of a systematic kind to this great subject. The contents of each stomach have been tabulated, and the relative abundance of each form noted. In this manner it is possible to compare the food taken in one district with that sought after in another, and likewise to note any change in diet at different seasons. On this account it has seemed advisable to limit the reports solely to the material which we have examined, and not to include any information which has been supplied by other authors. The Reports thus become simply catalogues of the contents of a large number of stomachs supplemented by conclusions which it is deemed are justified by the statistics given. Our first Reports are necessarily only tentative, and much information is still required, which can only be obtained when we have facilities for studying

the subject from another point of view. More particularly it is necessary to know not only what forms are found in a fish's stomach, but also the relative abundance of these forms in the sea itself, and also what choice of food material was at the time available. Our attention must ultimately be directed to the conditions under which the 'food material' itself exists. For the present, only one part of this subject has been studied. During the time that the Fishery Board's Laboratory was open in Loch Fyne, Mr Calderwood made frequent collections of the Copepods found in the district. It has thus been possible to compare in this case the number and frequency of the forms ascertained by surface dredging with those actually found in the stomach of the herring.

I.

REPORT ON THE FOOD OF THE HERRING. By G. Brook, F.L.S., and W. L. Calderwood.

The food of the herring has frequently formed the subject for inquiry during the past few years, both in this and other countries, and we are already in possession of much valuable information on the subject. So long ago as 1843 Goodsir pointed out that the herring on the East Coast followed the large shoals of Entomostraca from place to place, and that the presence of herring near our shores was largely dependent on the abundance of free swimming crustacea in the inshore waters. Sars has shown that off the Loffoden Islands the *Calanidæ* supply the most abundant forms of herring food, *Calanus finmarchicus* and *Temora longicornis* being particularly abundant.

Mr Sim has also devoted considerable attention to the study of herring food, and has described a large number of forms occurring on the East Coast of Scotland. More recently the question has been studied by Mr Piercy and others, while Dr Möbius has given a list of the chief food forms of the Baltic herring.

The material on which the present report is based has been supplied during the past two years by the officers of the Board at the chief fishing centres. Altogether, many thousand stomachs have been examined, and over two thousand which contained food have been transmitted to the central laboratory preserved in spirit. We have received considerable assistance in the identification of specimens from Mr Scott, Mr Jamieson, and others employed by the Scientific Committee of the Board. From April to November last a large amount of material was examined in a fresh condition at Tarbert, and compared with the living forms obtained by the tow-net. The importance of such a comparison can scarcely be over-estimated, and in the future we may expect to obtain the most instructive results from a study of the food forms themselves, and of the physical conditions affecting their distribution. This is more particularly the case with the herring, mackerel, and other fishes whose migrations are, to a great extent, dependent on the distribution of the immense shoals of pelagic crustacea on which they feed. Widegren has already called attention to this point. Speaking of the Copepods as forming a large part of the food of the herring, he says:—'Their quantity varies in 'different seasons, during a change of temperature, and at different depths, 'and this probably is the reason why these fishes are taken at different 'depths, in accordance with temperature and currents.'

The food of the herring being chiefly pelagic, the shoals of fish are

usually found in the upper waters, excepting during the spawning period. An apparent exception to this rule has, however, recently been brought under our notice. An important long-line fishery is prosecuted off the Blackwater (Arran), by Campbeltown fishermen in the spring, the chief forms taken being cod, ling, and skate. During the latter part of March and early in April the skate brought into Campbeltown were found to have their stomachs filled with herring. The herring in the district at this time are mostly spent fish, and as skate are essentially bottom-feeders, it is evident that the herring found in their stomachs must have been captured at the bottom. The fact that the food forms are pelagic in their habit accounts for the great variety of species found in the stomachs, particularly during the spring and summer months. Möbius has suggested that the herring does not discriminate between one form of food and another when feeding on the more minute species, but that the swarms of microscopic animals which are diffused through the sea are drawn into the mouth along with the water of respiration, and are retained there, while the water passes out through the opercula. The herring would thus appear to obtain its food in a similar manner to the whalebone whale (*Balæna*), so far as the copepods and other minute forms are concerned. It thus happens that copepods, larval stages of decapods, pelagic fish ova, and other forms are often found together in the same stomach, and the relative abundance of each depends on their frequency in the sea itself.

Möbius has also described several truly littoral forms of amphipods and annelids on which the herring feeds in the shallower parts of the Baltic. These are common littoral forms with us, but it does not appear that they frequently form a part of the herring's food around the Scotch Coast, probably for the reason that the herring do not frequent the localities in which these forms abound.

The period during which most food is taken by the herring varies on different parts of the coast, and occurs usually between the spawning seasons, while the sexual products are being matured. Speaking generally, there are two great spawning seasons both on the East and West Coasts, one in the spring and the other in the autumn. The dates and duration of each vary, however, in different districts. It also appears that the herring on the East Coast take most food during the winter and spring, while on the West Coast the summer is the great feeding season. This fact alone is sufficient to account for the marked contrast between the food taken on the two coasts, and to make it necessary to study the two questions separately. In the present report, however, our attention has been mainly directed to an examination of the food which is taken by the herring all around our coasts, and the question of supply and demand in any particular district must be left for further investigation. In studying this question one cannot fail to remark the great proportion of stomachs which, at certain seasons, do not contain food. As yet, we have no accurate data on this point, but it appears probable that the period during which little or no food is taken is not confined to the spawning season. During a part of the months of June and July we failed to obtain any herring containing food in Loch Fyne, although those examined were not yet ripe, and food was plentiful in the district. Earlier in the season almost every stomach examined was crammed with food, but, towards the end of July, the percentage of stomachs containing food and also the quantity in each diminished considerably. In November, those examined from the Sound of Bute were all empty, while all those from the Sound of Kilbrannan contained a fair quantity of food. At Lybster in the beginning of February, 6000 herring were examined, only three of which had any food in their stomachs. The percentage of stomachs containing food

is also very low during the great East Coast fishery, and often in certain parts during February and March.

As it has not been possible to identifiy the species in a large number of the stomachs examined, we have simply indicated the group to which these belonged. In the accompanying table, an analysis is given of the contents of a very large proportion of the stomachs examined, and the fishing centres from which they were received have been somewhat arbitrarily grouped together into districts.

Three symbols are used to indicate the comparative abundance of each group of food forms. The × signifies great abundance, the — is used when very few specimens have been found or when they formed only an insignificant amount of the food, while the † indicates an intermediate quantity. If we had been enabled to examine all the material in a fresh condition, it is probable that more species would have been identified, and it is probably owing partly to this reason that we have failed to recognise several of the species described by Mr Sim. Others described by the same author are rare and possibly local, while such forms as *Galathea* are probably of rare occurrence as food of the herring. It is a significant fact that we have not recognised a single specimen of the genus *Mysis*, and *Siriella* has only been met with occasionally.

HYPERIIDÆ.

Hyperia galba.—This species must be reckoned as one of the most important forms of herring food. Judging from its frequency in the stomach of the herring, this form must exist in myriads off the East Coast of Scotland. The male is smaller than the female and leads an active pelagic existence. In structure it is so different that it has been described as a distinct genus (*Lestrigonus*). The males occur in much greater abundance than the females in the stomachs which we have examined, an occurrence which is doubtless to be attributed to the difference in habit of the two sexes. The female occurs plentifully in the summer time under the umbrella of *Aurelia, Rhizostoma*, and other Medusæ. We are not, however, acquainted with its habit during the colder months, that is during the period in which it is found as herring food. The distribution of *Hyperia* around the Scottish Coast, as brought out by the present statistics, is very interesting. It has not occurred in any of the stomachs examined from the Berwick district, probably for the reason that the herring fishing does not begin in that district until another class of food has taken the place of *Hyperia*.

In the Anstruther district *Hyperia* is extremely abundant in the stomach of the herring during the months of January and February. In March it does not occur in such great numbers, while the fish caught in the inshore waters during April and May do not appear to feed on either this or any other crustacean. Although stomachs were examined from this district in December, none of them contained any specimens of *Hyperia*, although this species is common in adjoining districts at that time.

In the Stonehaven and Aberdeen districts *Hyperia* is abundant in the herring's stomachs from December to April, but after the latter month this species was no longer found.

The statistics given for the area between Peterhead and Cromarty appear to show that *Hyperia* is frequent in that part in December, more abundant in January, while in February and March the supply gradually diminishes and the herring then seeks other food. A careful comparison, however, shows that so far as our material goes, *Hyperia* is by no means so abundant in this area as in those to the south of it.

APPENDIX F.—TABLE I.

Locality.	Date.	No. of Stomachs.	Hyperidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
BERWICK DISTRICT.														
Berwick,	1. VII.	2	†	...	...	...	...	...	...	...	...	...	†	Embryo univalves.
,,	,,	3	...	...	...	...	...	...	...	...	...	...	×	,,
,,	,,	3	...	...	...	...	...	...	...	...	...	...	×	,,
,,	,,	1	...	...	...	...	†	...	...	...	...	...	...	
,,	16. VII.	2	...	...	†	...	...	...	...	...	...	...	...	
,,	11. VIII.	1	...	...	...	...	...	...	...	...	...	—	...	
,,	24. VIII.	4	...	...	×	...	...	...	...	...	...	...	...	
Farne Islands,	1. IX.	5	...	...	...	...	...	...	...	...	...	†	...	
Off Coquet,	9. IX.	54	...	...	×	...	...	...	...	...	...	...	...	
,,	,,	11	...	...	×	...	...	...	...	...	...	...	...	Also bits of seaweed.
,,	,,	3	...	...	×	...	...	...	...	...	...	†	...	
,,	,,	1	...	...	×	...	†	...	...	...	...	...	...	
,,	,,	2	...	...	†	...	†	...	...	...	...	...	...	
,,	,,	2	...	...	†	...	...	...	...	...	...	...	...	Bits of seaweed.
,,	,,	2	...	...	†	...	...	...	...	...	...	...	...	1 piece of a Sertularian.
ANSTRUTHER AND THE FORTH.														
Anstruther,	8. I.	1	×	...	...	...	...	...	...	...	...	...	...	
The Forth,	,,	1	×	...	...	...	...	...	...	...	...	...	...	
,,	,,	2	×	...	...	...	...	†	...	...	...	...	...	
,,	,,	4	×	...	...	...	...	†	...	...	...	...	...	
,,	,,	1	×	×	...	...	...	—	...	...	...	...	...	
,,	9. I.	1	†	...	...	...	...	...	...	...	...	...	...	

Explanation of Symbols.—× = abundant; † = medium quantity; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
ANSTRUTHER, &c.—*continued.*														
The Forth, ...	12. I.	5	×	×	...	...	...	×	...	×	...	...	...	
Anstruther, ...	15. I.	1	×	...	...	...	...	...	...	...	...	...	...	
,, ...	16. I.	4	†	...	...	...	...	...	...	...	...	...	...	
The Forth, ...	16. I.	3	×	...	...	...	...	...	...	...	...	...	...	
Buckhaven, ...	,,	2	×	...	...	...	...	...	...	...	...	...	...	
Dysart, ...	,,	3	×	...	—*	...	...	...	...	...	...	...	...	* Calanus.
Anstruther, ...	17. I.	2	×	...	...	...	...	...	...	...	...	...	...	
The Forth, ...	18. I.	4	×	...	...	...	...	...	...	...	...	...	...	
,, ...	19. I.	7	×	...	...	...	...	×	...	×	...	...	...	
Anstruther, ...	,,	6	†	...	...	...	...	...	...	×	...	...	...	
,, ...	22. I.	1	...	×	...	...	...	...	...	...	...	...	...	
,, ...	,,	1	...	...	...	...	...	×	...	...	...	...	...	
,, ...	26. I.	1	×	...	...	...	...	†	...	...	...	...	...	
,, ...	30. I.	1	×	...	...	...	...	...	...	...	...	...	...	
The Forth, ...	30. I.	1	×	...	...	...	...	...	...	...	...	...	...	
Anstruther, ...	5. II.	8	...	×	...	...	...	†	...	...	†	...	...	
,, ...	6. II.	3	×	...	...	...	...	...	...	...	...	...	...	
The Forth, ...	,,	3	†	†	...	...	...	...	...	...	...	...	...	
,, ...	7. II.	4	...	×	...	...	...	...	...	...	...	...	...	
,, ...	8. II.	1	...	...	...	...	...	×	...	...	†	...	...	
Crail, ...	,,	1	×	...	...	...	...	...	...	...	...	...	...	
The Forth, ...	14. II.	2	×	...	...	...	...	...	...	...	...	...	...	
,, ...	23. II.	1	...	...	...	...	...	...	...	†	...	...	...	
,, ...	26. II.	1	...	×	...	...	...	...	...	...	...	...	...	Nyctiphanes.
,, ...	27. II.	3	×	×	...	...	...	†	...	...	...	...	...	
Anstruther, ...	5. III.	1	×	×	...	...	...	†	...	†	...	...	...	
,, ...	6. III.	6	×	×*	...	...	...	×	...	×	...	...	...	* Nyctiphanes.

Explanation of Symbols.—× = abundant; † = medium quantity; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
ANSTRUTHER, &c.—*continued.*														
The Forth,	6. III.	4	×	×	...	...	...	...	...	×	...	...	...	
,,	7. III.	5	...	×	...	...	...	×	...	...	...	...	...	
,,	8. III.	2	×	×	...	...	...	...	...	...	...	...	...	
Anstruther,	28. IV.	9	...	...	...	...	...	...	...	...	...	×	...	
May Island, 106 m. E.S.E.,	28. V.	8	...	...	...	...	...	...	...	...	...	×	...	
The Forth,	27. XII.	10	...	...	×?	...	...	...	...	...	...	...	...	
ABERDEEN TO DUNDEE.														
Aberdeen,	8. I.	2	×	...	...	...	...	...	...	...	...	...	...	
Stonehaven,	10. I.	1	×	†*	...	...	...	×	...	...	...	...	...	* Boreophausia?
,,	11. I.	4	×	×	...	...	...	×	...	...	...	...	...	
,,	,,	3	×	...	...	...	...	...	...	...	...	...	...	
Dundee,	17. I.	2	...	...	...	...	...	...	...	×	...	...	...	
,,	,,	3	...	...	...	...	...	...	...	×	...	...	...	
Stonehaven,	19. I.	5	×	...	...	...	...	...	...	...	...	...	...	
Aberdeen,	23. I.	1	×	...	...	...	...	...	...	...	...	...	...	
Stonehaven,	25. I.	2	×	...	...	...	...	×	...	...	...	...	...	
,,	26. I.	2	×	...	...	...	...	×	...	...	...	...	...	
,,	29. I.	5	×	×	...	...	...	×	...	...	...	...	...	
Aberdeen,	,,	1	...	×	...	...	...	...	...	...	...	...	...	
Dundee,	1. II.	2	...	...	...	...	...	...	...	×	...	...	...	
Stonehaven,	6. II.	7	×	†	...	...	...	†	...	...	...	...	...	
Dundee,	7. II.	5	...	...	...	...	...	...	...	×	...	...	...	
,,	9. II.	1	...	...	...	...	...	...	...	†	...	...	...	
Stonehaven,	12. II.	1	×	†	...	...	...	†	...	...	...	...	...	

Explanation of Symbols.—× = abundant; † = medium quantity; ▬ = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
ABERDEEN TO DUNDEE—*cont.*														
Dundee,	14. II.	7	...	...	...	...	...	...	...	×	...	...	...	
,,	27. II.	7	...	...	...	...	...	...	...	×	...	...	...	
Stonehaven,	17. IV.	6	×	×	...	...	...	...	...	...	...	...	...	
,,	6. V.	2	...	×	...	...	...	...	...	...	...	...	...	
,,	13. V.	2	...	×	...	...	...	...	...	...	...	...	...	
,,	23. V.	2	...	×	+*	...	...	...	...	...	...	...	...	* Calanus.
,,	,,	4	...	×	...	...	...	...	...	...	...	...	...	Young Euphausiidæ.
,,	30. V.	4	...	×	...	...	+	...	...	...	...	...	...	
,,	10. VI.	3	...	...	+	...	...	...	...	+	...	...	...	Also Caprella and a few other Amphipods.
,,	,,	3	...	+*	+	...	...	...	...	...	...	...	...	* Boreophausia.
Aberdeen,	17. VI.	2	...	...	...	...	+	...	...	...	...	...	+*	* A small Doris
,,	19. VI.	6	...	+	...	...	...	...	...	...	...	...	...	
,,	27. VI.	1	...	...	+	...	...	...	...	...	...	...	...	
,,	26. VIII.	3	...	...	...	...	...	...	...	...	...	×	...	
,,	,,	1	...	...	+	...	...	...	...	...	...	...	...	
Stonehaven,	6. XII.	4	×	...	...	...	...	...	...	...	...	...	...	
,,	22. XII.	2	×	+	...	...	...	...	...	...	...	...	...	
CROMARTY TO PETERHEAD.														
Buckie,	10. I.	2	...	×	...	...	...	—	...	...	...	...	...	
Beauly,	,,	1	×	...	...	...	...	...	...	...	...	...	...	
Buckie,	12. I.	3	+	×	...	...	...	...	...	...	...	...	...	
Burghead,	,,	1	×	...	...	...	...	...	...	...	...	...	...	
Buckie,	,,	3	...	×	...	...	...	...	...	...	...	...	...	

Explanation of Symbols.—× = abundant; + = medium quantity; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
CROMARTY, &c.—*continued.*														
Burghead,	15. I.	1	×	...	...	...	...	...	...	...	...	+	...	
,,	19. I.	1	×	...	...	...	...	+	...	...	—	...	...	
Buckie,	,,	1	...	×	...	...	...	...	...	...	...	...	...	
,,	,,	1	×	...	...	...	...	...	...	...	...	...	...	
Cromarty,	21. I.	2	...	...	...	...	...	...	...	×	...	...	...	
Burghead,	22. I.	1	...	+	...	...	...	...	...	...	...	+	...	
,,	23. I.	1	—	×	...	...	...	...	—	...	...	...	...	
Macduff,	24. I.	8	×	×*	...	...	...	×	—	...	...	×	...	* Young Nyctiphanes.
Burghead,	,,	1	×	...	...	...	...	...	...	...	...	—	...	
,,	25. I.	1	×	×	...	...	...	...	...	...	...	...	...	
,,	,,	1	—	×	...	...	...	...	...	...	...	...	...	
Buckie,	25. I.	2	×	...	...	...	...	...	...	...	...	...	...	
,,	,,	1	...	×	...	...	...	...	...	...	...	...	...	
,,	,,	3	×	×	...	...	...	...	...	...	...	...	...	
,,	26. I.	1	...	×	...	...	...	...	...	...	...	...	...	
,,	,,	1	×	...	...	...	...	...	...	...	...	...	...	And a polyzoon.
,,	,,	2	...	...	+	...	...	...	...	...	...	...	...	
Peterhead,	29. I.	2	×	...	...	...	...	×	...	...	...	...	...	
,,	,,	1	...	×	...	...	...	...	...	...	...	...	...	
,,	,,	2	×	+*	...	...	...	...	...	...	...	...	...	* Young Euphausiidæ.
Macduff,	1. II.	1	...	...	...	...	...	+	...	...	×	...	...	
Buckie,	2. II.	1	...	×	...	...	...	...	...	...	...	...	...	
Peterhead,	4. II.	3	—	...	...	...	...	...	...	...	...	...	...	
Buckie,	5. II.	1	×	...	...	...	...	...	...	+*	...	...	...	* Fish eyes.
Peterhead,	,,	2	...	×	...	...	...	...	...	...	...	...	...	
Macduff,	,,	1	...	...	...	...	...	...	...	×	...	...	...	
Burghead,	7. II.	1	...	+	...	...	...	...	...	...	...	—	...	

Explanation of Symbols.—× = abundant; + = medium quantity; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
CROMARTY, &c.—*continued.*														
Burghead,	7. II.	1	—	×	...	...	...	...	...	...	...	...	...	
Buckie,	9. II.	2	×	...	...	...	...	...	...	...	...	...	...	
,,	,,	1	...	×	...	...	...	...	...	...	...	×	...	
Burghead,	13. II.	1	...	×	...	...	...	...	...	...	...	...	...	
,,	,,	1	†	×	...	...	...	...	...	...	...	...	...	
,,	14. II.	1	...	×	...	...	...	...	...	...	...	...	...	
,,	,,	2	...	×	...	...	...	...	...	†	†	...	...	
,,	15. II.	1	...	×	...	...	...	...	...	...	...	...	...	
Peterhead,	,,	1	—	...	...	...	...	†	...	...	...	...	...	
Buckie,	16. II.	1	...	×	...	...	...	...	...	...	...	...	...	
Fraserburgh,	18. II.	6	×	...	...	...	...	...	...	†	...	...	...	
Macduff,	19. II.	5	...	†	...	...	...	...	...	...	...	...	...	} 78 others were empty.
,,	,,	1	—	†	...	...	...	...	...	...	...	...	...	
Burghead,	27. II.	1	...	...	...	...	...	...	...	†	...	...	...	
Buckie,	6. III.	1	—	—	...	...	...	...	...	—	...	...	...	46 others were empty.
Burghead,	7. III.	1	—	†	...	...	...	...	...	...	—	...	...	
Fraserburgh,	4. VI.	6	...	...	...	...	...	...	...	×	...	...	...	
Macduff,	17. VI.	4	...	...	...	...	...	...	...	...	×	...	...	16, 36, 29, 32 Ammodytes.
Buckie,	8. VII.	6	...	...	×	...	...	...	...	...	...	...	...	
,,	10. VII.	8	...	...	×	...	...	...	...	...	...	...	...	
Burghead,	15. VII.	1	...	...	×	...	...	...	...	...	...	...	...	
Peterhead,	,,	1	...	...	×	...	...	...	...	...	...	...	...	
Burghead,	16. VII.	2	...	...	×	...	...	...	...	...	...	...	...	
,,	17. VII.	1	...	...	†	...	...	...	...	...	...	...	...	
,,	21. VII.	1	...	...	†	...	...	...	...	...	...	...	...	
,,	22. VII.	1	...	...	†	...	—	...	...	...	...	...	...	
Buckie,	6. VIII.	8	...	...	...	...	...	...	...	...	×	...	...	

Explanation of Symbols.—× = abundant ; † = medium quantity ; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
CROMARTY, &c.—*continued.*														
Fraserburgh,	21. VIII.	6	...	...	†	...	...	...	...	...	...	×	†*	* Embryo univalves.
,,	27. VIII.	8	...	...	†	...	...	...	...	...	...	...	...	
,,	,,	1	...	...	...	...	...	...	...	...	...	...	...	
Peterhead,	1. IX.	50	...	...	†	...	—	...	...	...	...	—	...	
,,	,,	3	...	...	...	...	...	...	...	...	...	×	...	
Buckie,	15. IX.	10	...	...	×	...	...	...	...	...	...	...	...	
Beauly,	17. XII.	2	—	×	...	...	...	...	...	...	...	...	...	
,,	,,	1	...	×	...	...	...	...	...	...	...	...	...	
,,	,,	1	...	...	...	...	...	...	...	×	...	...	...	
,,	26. XII.	1	×	...	...	...	...	...	...	...	...	...	...	
WICK DISTRICT.														
Lybster,	4. I.	2	...	×	...	...	...	...	...	...	...	...	...	Nyctiphanes.
,,	,,	2	†	×	...	...	...	...	...	...	...	...	...	
,,	,,	1	...	...	...	...	...	...	...	†	...	...	...	
,,	5. I.	2	×	×*	...	...	...	...	...	...	...	...	...	* Nyctiphanes.
,,	,,	1	×	×	...	...	...	...	...	†	...	...	...	
,,	8. I.	1	...	×	...	...	...	...	...	...	...	...	...	
Wick,	,,	2	...	×	...	...	...	...	...	...	...	...	...	
,,	10. I.	1	...	×	...	...	...	...	...	...	...	...	...	
Helmsdale,	,,	1	×	×	...	...	...	...	...	...	...	...	...	
,,	,,	1	×	×	...	...	...	...	...	...	...	—	...	
,,	,,	2	×	...	...	...	...	...	...	...	...	...	...	
,,	21. I.	2	...	×	...	...	...	...	...	...	...	...	...	
,,	,,	3	...	...	×	...	...	...	...	...	...	...	...	

Explanation of Symbols.— × = abundant ; † = medium quantity ; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

LOCALITY.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	REMARKS.
WICK DISTRICT—*continued.*														
Wick,	21. I.	2	+	...	...	...	...	...	...	...	...	+	...	
,,	,,	6	+	...	...	...	...	...	...	...	...	...	...	5 others empty.
Lybster,	,,	1	—	...	...	...	—	...	...	×	...	...	...	
,,	,,	1	—	—	...	...	...	...	...	×	...	—	...	
,,	,,	1	—	×	...	...	...	...	...	...	...	+	...	
Wick,	22. I.	1	...	×	...	...	...	...	...	...	...	...	...	
,,	23. I.	2	...	×	...	...	...	...	...	...	...	...	...	Nyctiphanes.
Lybster,	,,	1	...	×	...	...	...	...	...	...	...	...	...	,,
Wick,	,,	2	×	×	...	...	...	...	...	...	...	...	...	
Helmsdale,	24. I.	1	×	...	...	...	...	...	...	...	...	...	...	
Wick,	26. I.	1	—	×	...	...	...	...	...	...	...	...	...	
,,	,,	1	...	×	...	...	...	...	...	...	×	...	...	
Helmsdale,	27. I.	4	+	×	...	...	...	...	...	...	...	+	...	
Wick,	28. I.	1	+	×	...	...	...	...	...	+	...	...	...	
,,	,,	10	×	...	...	...	...	...	...	...	...	...	...	
,,	,,	1	...	×	...	...	...	...	...	...	...	...	...	
,,	29. I.	2	...	×	...	...	...	...	...	...	...	...	...	Nyctiphanes.
,,	,,	1	...	×*	...	...	...	...	...	+	...	...	...	* Euphausiidæ.
Helmsdale,	,,	2	...	×	...	...	...	...	...	...	...	...	...	
Lybster,	30. I.	2	+	×*	...	...	...	...	...	...	...	+	...	* Euphausiidæ.
,,	,,	1	+	×	...	...	...	+	...	+	...	...	...	
Wick,	1. II.	1	...	...	...	...	...	...	—	...	...	...	...	
,,	,,	3	...	×	...	...	...	...	...	...	...	...	...	
,,	2. II.	5	×	...	...	...	...	...	...	...	...	...	...	
,,	,,	1	+	×	...	...	...	...	...	...	...	...	...	
,,	,,	2	...	...	...	...	...	...	...	+	...	...	...	
,,	,,	4	...	×	...	...	...	...	...	...	...	...	...	

Explanation of Symbols.—× = abundant; + = medium quantity; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
WICK DISTRICT—*continued.*														
Lybster,	2. II.	2	...	...	...	...	...	...	...	+	...	...	...	} 3 in 6000 contained food.
"	"	1	+	×*	* (young Euphausiidæ.)			...	...	...	...	...	...	
Wick,	3. II.	1	...	...	...	...	...	...	...	...	...	×	...	
"	"	5	+	×	...	...	...	...	...	...	...	+	...	
Helmsdale,	"	4	—	×	...	...	...	...	...	...	...	—	...	
Wick,	4. II.	2	+	...	...	...	...	...	...	...	...	...	...	
"	"	1	+	...	...	•••	...	+	...	+	...	...	...	
"	"	2	×	...	...	...	...	...	...	...	...	+	...	
"	"	1	—	×	...	...	...	...	...	...	...	—	...	
"	"	1	×	—	...	...	...	...	...	+	...	...	...	
"	"	1	+	...	...	...	...	...	...	...	...	×	...	
"	"	3	+	...	...	...	...	...	...	...	...	...	...	
Lybster,	5. II.	2	...	×	...	...	...	•••	...	...	...	...	...	
"	"	1	...	...	...	...	...	...	...	×	...	...	...	
Wick,	6. II.	3	...	×	...	...	...	+	...	...	...	...	...	
Lybster,	"	1	...	×	...	...	...	...	...	...	...	...	...	
Wick,	7. II.	2	...	×	...	...	...	...	...	...	...	...	...	
"	"	2	...	×	...	...	...	...	...	×	...	...	...	
"	10. II.	3	—	×	...	...	...	...	...	...	...	...	...	
"	"	1	×	×	...	...	...	...	...	...	...	...	...	
"	"	2	×	—	...	...	...	...	...	...	...	...	...	
"	"	1	...	...	...	...	...	...	•••	+	...	...	...	
"	"	2	×	+	...	...	...	...	...	+	...	...	...	
	"	2	+	×*	...	...	...	...	...	...	...	...	...	* Young Euphausiidæ.
"	"	1	+	...	...	...	...	...	...	...	...	...	...	
"	11. II.	6	×	×*	...	...	...	...	...	...	...	...	...	* Nyctiphanes.
Lybster,	"	2	—	×	...	...	...	...	...	...	...	...	...	

Explanation of Symbols.—× = abundant ; + = medium quantity ; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
WICK DISTRICT—*continued.*														
Lybster, ...	11. II.	1	...	...	...	...	...	...	...	+	...	...	...	
Wick, ...	12. II.	4	...	×	...	...	...	...	...	...	...	...	...	Nyctiphanes.
Lybster, ...	,,	2	—	—	...	...	...	...	...	+	...	...	...	
,, ...	,,	1	+	×	...	...	...	...	...	...	...	...	...	
Wick, ...	17. II.	4	×	×	...	...	...	...	...	...	...	+	...	
,, ...	,,	1	...	...	...	...	...	...	...	+	...	...	...	
,, ...	,,	1	...	...	...	...	...	...	+	...	...	...	...	
,, ...	,,	5	×	...	...	...	...	...	...	...	...	+	...	
,, ...	,,	1	...	...	...	...	...	...	+	...	...	+	...	
,, ...	18. II.	1	...	...	...	...	...	...	...	...	...	+	...	
,, ...	,,	2	×	+	...	...	...	...	...	...	...	...	...	
,, ...	,,	2	...	...	...	...	...	...	...	+	...	...	...	
,, ...	,,	3	×	...	...	...	...	...	...	...	...	+	...	
,, ...	,,	1	...	...	...	...	...	...	+	...	...	+	...	
Helmsdale, ...	20. II.	3	...	...	...	...	...	...	...	...	...	×	...	
,, ...	,,	2	+	...	...	...	...	...	...	+	...	...	...	
Wick, ...	22. II.	4	...	×	...	...	...	...	...	...	...	...	...	
Helmsdale, ...	25. II.	1	...	×	...	—	...	...	...	...	...	...	...	
Wick, ...	,,	4	...	×	...	...	...	...	...	...	...	...	...	
,, ...	,,	2	+	×	...	...	...	...	...	+	...	...	...	
,, ...	,,	1	+	×	...	...	...	...	...	...	...	×	...	
,, ...	,,	4	...	+	...	...	...	...	...	...	...	...	...	
,, ...	26. II.	5	...	×	...	...	...	...	...	...	...	×	...	
,, ...	,,	2	...	+	...	...	...	...	...	...	...	—	...	
,, ...	,,	1	—	×	...	...	...	...	...	...	...	...	...	
,, ...	,,	2	...	×	...	...	...	...	...	...	...	...	...	And young Gadidæ.
,, ...	,,	5	...	×	...	...	...	...	...	...	...	...	...	Nyctiphanes.

Explanation of Symbols.—× = abundant; + = medium quantity; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostrapods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
WICK DISTRICT—*continued.*														
Lybster,	27. II.	2	...	×	...	...	...	...	...	...	...	...	...	
,,	18. III.	1	...	...	...	...	...	...	...	×	...	...	...	
,,	,,	2	...	†	...	...	...	...	...	×	×	...	...	
,,	25. III.	5	...	×	...	...	...	...	...	...	...	...	...	Euphausiidæ.
,,	30. III.	1	...	×	...	...	...	...	...	...	...	...	...	
Wick,	9. VII.	1	...	...	†	...	...	...	...	...	...	...	...	
,,	,,	1	...	...	†	...	—	...	...	...	...	...	...	
,,	,,	1	...	...	...	...	...	...	...	...	×	...	...	
,,	,,	2	...	...	×	...	...	...	...	...	...	...	...	
,,	10. VII.	3	...	...	×	...	...	...	...	...	...	...	...	
,,	11. VII.	1	...	...	†	...	...	...	...	...	...	...	...	
,,	,,	2	...	...	†	×	...	...	...	...	...	...	...	
,,	,,	1	...	...	†	†	...	...	...	...	...	...	...	
,,	14. VII.	3	...	...	†	...	...	...	...	...	...	...	...	
,,	,,	1	...	...	×	...	—	...	...	...	...	...	...	
,,	,,	2	...	...	†	...	...	...	...	...	...	—	...	
,,	15. VII.	6	...	...	†	...	...	...	...	...	...	...	...	
,,	,,	1	...	...	†	...	...	...	...	...	...	×	...	
,,	,,	1	...	...	†	...	—	...	...	...	...	...	...	
,,	,,	1	...	...	...	...	...	...	...	...	...	—	...	
,,	,,	1	...	...	...	...	...	...	...	...	...	...	†	Univalve embryos.
,,	,,	1	...	...	...	...	...	...	...	...	×	...	...	
,,	16. VII.	3	...	...	†	...	...	...	...	...	...	...	...	
,,	21. VII.	1	...	...	†	...	...	...	...	...	...	...	...	
,,	,,	4	...	...	†	...	—	...	...	...	...	...	...	
,,	,,	1	...	...	...	...	†	...	...	...	...	...	...	
,,	22. VII.	2	...	...	†	...	—	...	...	...	...	...	...	

Explanation of Symbols.—× = abundant; † = medium quantity; — = very few

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
WICK DISTRICT *continued.*														
Wick,	22. VII.	1	...	...	...	...	—	...	—	...	...	...	...	
"	"	1	...	...	+	...	...	...	...	...	...	...	...	
"	23. VII.	6	...	...	+	...	...	...	...	...	...	...	...	
"	"	1	...	...	+	+	...	...	...	...	...	...	...	
"	"	1	...	...	...	+	...	...	...	...	...	...	...	
"	"	1	?	—	+	...	...	...	...	...	...	—	...	
"	"	1	...	...	+	...	—	...	...	...	...	—	...	
"	28. VII.	1	...	...	+	...	...	...	...	...	...	...	...	
"	"	1	...	...	+	...	...	...	...	...	...	—	...	
"	29. VII.	3	...	...	+	...	...	...	...	...	...	...	...	
"	30. VII.	5	...	...	+	...	...	...	...	...	...	...	...	
Lybster,	16. XII.	2	×	×	...	...	...	...	...	...	...	...	...	
"	20. XII.	3	+	×*	...	...	...	...	...	...	...	...	...	* Nyctiphanes.
"	"	1	...	×*	+	...	...	...	...	...	...	...	...	* "
SHETLAND.														
Lerwick,	3. IV.	5	...	×	...	...	...	...	...	...	...	...	...	
"	4. IV.	5	...	×	...	...	...	...	...	...	...	...	...	
"	18. IV.	7	...	...	×	...	...	...	...	...	...	...	...	Calanus finmarchicus.
Rooeness Voe,	28. IV.	1	...	...	+*	...	+	...	...	...	...	...	...	* Calanus.
Lerwick,	29. IV.	2	...	...	×	...	...	...	...	...	...	...	...	Calanus finmarchicus.
"	30. IV	1	...	×	...	...	...	...	...	...	...	...	...	
Noss,	24. VI.	1	+	...	...	...	...	...	...	...	...	...	...	

Explanation of Symbols.—× = abundant; + = medium quantity; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
STORNOWAY DISTRICT.														
Butt of Lewis, ...	15. IV.	3	...	×	...	...	...	...	...	...	...	...	...	
,, ...	16. IV.	3	...	×	...	...	...	...	...	...	...	...	...	
Stornoway, ...	,,	1	...	×	...	...	...	...	...	...	...	...	...	Nyctiphanes.
Butt of Lewis, . . .	,,	1	...	×	...	...	...	...	...	...	...	...	...	
,, ...	25. IV.	2	...	×	...	...	...	...	...	...	...	...	...	Nyctiphanes.
,, ...	,,	2	...	×	...	...	...	...	...	...	...	...	...	
,, ...	12. V.	1	...	+	...	...	...	...	...	×	...	...	...	
,, ...	,,	1	...	×	...	...	...	...	...	...	...	...	...	
,, ...	15. V.	2	...	+	...	...	...	...	...	×	...	...	...	
,, ...	,,	1	...	...	...	...	+	...	...	...	...	×	...	
,, ...	,,	4	...	+	...	...	...	...	...	...	...	×	...	
,, ...	,,	1	...	×	...	...	—	...	...	...	...	...	...	
,, ...	,,	1	...	...	...	...	...	...	...	...	...	×	...	
Tolsta Head, ...	17. V.	2	...	×	...	...	...	...	...	...	...	...	...	
Cellar Head, ...	20. V.	1	...	...	×	...	...	...	...	...	...	...	...	
,, ...	,,	1	...	+	+	...	—	...	...	...	...	...	...	
,, ...	,,	1	...	×	...	...	...	...	...	...	...	...	...	
Tolsta Head, ...	21. V.	5	...	+*	×	(Calan	us finmarc	hicus)	...	...	...	...	...	* Young Euphausiidæ.
Shiant Island, ...	24. V.	4	...	×	+	(Calan	us)	...	...	...	...	...	...	
Tiumpan Head, . . .	26. V.	2	...	×	...	...	...	...	...	+	...	...	...	
Cellar Head, ...	27. V.	2	...	+*	×	...	...	...	...	...	...	...	...	* Young Euphausiidæ.
Barra, ...	3. VI.	3	...	—*	×	...	+	...	...	...	...	...	...	* Boreophausia ?
Cellar Head, ...	4. VI.	1	...	...	+	...	...	...	...	...	...	...	...	Centropages.
Loch Laxford, ...	6. VI.	3	...	×	...	...	...	...	...	...	...	...	...	Nyctiphanes.
Stair Head, ...	,,	3	...	×	+	...	...	...	...	+	...	...	...	
Bible Head, ...	10. VI.	1	...	+*	+	(Calan	us) ...	...	...	+	...	...	...	* Young Euphausiidæ.
Cape Wrath, ...	11. VI.	2	...	...	...	...	...	...	...	×	...	...	...	

Explanation of Symbols.—× = abunda t; + = medium quantity; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
STORNOWAY DISTRICT—*cont.*														
Stornoway,	17. VI.	1	...	†*	†	...	—	...	...	...	...	...	...	* Young Euphausiidæ.
Butt of Lewis,	,,	1	...	...	×	...	...	...	...	...	...	...	...	
Chicken Head,	,,	2	...	†	†	(Pseu	docalanus	and a	few Ca	lanus)	...	...	...	
Stornoway,	,,	1	...	×	...	...	...	...	...	...	...	...	...	
Butt of Lewis,	,,	4	...	...	×	...	...	...	...	...	...	...	...	
Tiumpan Head,	,,	1	...	×	†*	...	...	...	...	...	...	...	...	* Pseudocalanus.
Chicken Head,	,,	1	...	×	...	...	...	...	...	...	...	...	...	Boreophausia.
Cellar Head,	18. VI.	1	...	—	×	...	...	...	...	...	...	...	...	Pseudocalanus elongatus.
,,	,,	1	...	...	×	...	...	...	...	...	...	...	...	,,
Tiumpan Head,	24. VI.	5	...	...	...	...	...	...	...	†	...	...	...	2 young Carcinus.
LOCH BROOM DISTRICT.														
Loch Gruinard,	25. III.	1	...	×	...	...	...	...	...	...	...	—	...	
Loch Broom,	28. III.	1	...	×	...	...	...	...	...	...	...	—	...	
,,	15. X.	6	...	×	...	...	...	...	...	...	...	...	...	Boreophausia.
,,	,,	1	...	×	...	...	...	...	...	†	...	...	...	
,,	5. XI.	1	...	×	...	...	...	...	...	...	...	...	...	
,,	19. XI.	1	...	×	...	...	...	...	...	...	...	...	...	Boreophausia.
,,	20. XI.	2	...	×	...	...	...	...	...	...	...	...	...	,,
,,	25. XI.	1	...	†	...	...	...	...	...	...	...	...	...	,,
,,	2. XII.	1	...	×	(Nycti	phane	s and Boreo	phausi	a)	...	...	...	...	3 small pieces of shell.
OBAN DISTRICT.	75 Stomachs, sent in during October and November, were all empty, or contained only Herring Scales.													

Explanation of Symbols.— × = abundant ; † = medium quantity ; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
LOCHFYNE DISTRICT.														
Lochfyne, ...	20. IV.	1	...	...	×	...	...	...	...	...	...	...	...	
,, ...	21. IV.	3	...	...	×	...	...	...	...	...	...	...	...	
,, ...	,,	1	...	...	×	...	...	...	...	...	...	...	...	Calanus finmarchicus.
,, ...	,,	1	...	—	×	...	...	...	...	...	...	...	...	
Tarbert, ...	18. IV.	4	...	...	†	...	...	...	...	...	...	...	...	
,, ...	26. IV.	3	...	...	×	...	...	...	...	...	...	...	...	
Sound of Kilbrannan, . .	7. V.	5	...	...	×	...	...	...	...	...	...	...	...	
,, ...	,,	7	...	...	×	...	†	...	...	...	...	...	...	Young Hippolyte.
Lochfyne, ...	15. V.	2	...	†	×*	...	...	...	...	...	...	...	...	* Calanus.
Ardrishaig, ...	,,	3	...	†	×	...	...	...	...	...	...	...	...	
Port Bannatyne, ...	16. V.	4	...	...	×	...	...	...	...	...	...	...	...	
Ardlamont Point, ...	,,	3	...	...	×	...	...	...	...	†	...	...	...	
Tarbert, ...	10. V.	all exa-	...	...	×	...	—	...	...	...	...	...	...	
,, ...	23. V.	mined.	...	...	×	...	—	...	...	...	...	...	...	
Lochfyne, ...	10. VI.	3	...	...	×	...	...	...	...	...	...	...	...	Calanus finmarchicus.
,, ...	16. VI.	3	...	...	×	...	...	...	...	...	...	...	...	
,, ...	17. VI.	4	...	...	×	...	...	...	...	...	...	...	...	
,, ...	18. VI.	2	...	—*	×	...	...	...	...	...	...	...	...	* Young Euphausiidæ.
,, ...	20. VI.	1	...	—	×*	...	—	...	...	...	...	...	...	* Metridia armata?
,, ...	21. VI.	1	...	—	×	...	—	...	...	...	...	...	...	
,, ...	,,	1	...	—	×	...	...	...	...	...	...	...	...	
,, ...	26. VI.	1	...	...	×	...	...	...	...	...	...	...	...	Calanus finmarchicus.
,, ...	,,	3	...	...	×	...	†	...	...	...	...	...	...	
,, ...	,,	1	...	—	×	...	...	...	...	—	...	...	...	
,, ...	27. VI.	2	...	...	†	...	...	...	...	×	...	...	...	
,, ...	28. VI.	3	...	†*	×	(Calan	us finmarc	hicus)	...	—	...	...	...	* Young Euphausiidæ.
Tarbert, ...	1–20. VI.	50	...	...	×	...	—	...	...	...	...	...	...	Many empty.

Explanation of Symbols.—× = abundant; † = medium quantity; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Melagops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
LOCHFYNE DISTRICT—*cont.*														
Tarbert,	25. VI.	8	...	...	×	...	...	...	...	...	...	...	...	
Lochfyne,	4. VII.	4	..	...	×	...	...	...	...	...	...	...	...	
„	16. VII.	3	...	...	+	...	...	..	...	...	...	...	...	
Tarbert,	1–10. VII.	30	...	...	+	...	...	...	...	...	...	...	...	Many empty.
„	17–35. VII.	26	...	...	+	...	...	...	...	...	...	...	...	„
Tarbert,	19. VIII.	2	...	...	+	...	...	...	...	...	...	...	...	Centropages typicus; 10 other stom. empty.
„	20. VIII.	1	...	...	+	...	...	...	...	...	...	...	...	50 other stom. empty.
„	21. VIII.	2	...	...	+	...	...	...	...	...	...	...	...	11 others empty.
„	22. VIII.	1	...	...	+	...	...	...	...	...	...	...	...	8 others empty.
„	27. VIII.	7	...	...	+	...	...	...	...	...	...	...	...	Including Calanus finmarchicus; 5 others empty.
„	28. VIII.	7	...	...	+	...	...	...	...	...	...	...	...	
„	„	5	...	...	×	...	...	...	...	...	...	...	...	Including Dias, Centropages and Calanus.
„	„	1	...	...	×	...	...	...	—	...	...	...	...	Also *Evadne?*
„	1. IX.	3	...	...	+	...	...	...	...	...	...	...	...	Including Centropages; 15 others empty.
„	2. IX.	2	...	+	...	...	...	...	...	...	...	...	...	7 others empty.
„	4. IX.	10	...	+	+	...	...	...	...	...	...	...	...	„
„	8. IX.	1	...	...	...	...	...	...	...	...	...	+	...	16 others empty.
„	9. IX.	10	...	+	+	...	...	...	...	...	...	...	...	3 others empty.
„	10. IX.	20	...	...	+	...	...	...	...	...	...	...	...	Including Calanus and Centropages; 7 others empty.
„	11. IX.	5	...	...	+	...	...	...	...	...	...	...	...	
„	„	1	...	+	+	...	...	...	...	...	...	...	...	Including Dias and Centropages; 16 others empty.

Explanation of Symbols.— × = abundant; + = medium quantity; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
LOCHFYNE DISTRICT—*cont.*														
Tarbert, ...	12. IX.	8	...	...	+	...	...	...	...	...	...	...	...	12 others empty.
,, ...	16. IX.	12	...	...	...	...	...	...	...	...	...	...	...	All empty.
,, ...	18. IX.	30	...	...	...	...	...	...	...	...	...	...	...	,,
,, ...	19. IX.	13	...	+	+	...	...	...	...	...	...	...	...	15 others empty.
,, ...	22. IX.	4	...	+	...	...	...	...	...	...	...	...	...	75 others empty.
,, ...	23. IX.	2	...	+	...	...	...	...	...	...	...	...	...	5 others empty.
,, ...	22. X.	7	...	...	...	...	...	...	...	...	...	...	...	All empty.
,, ...	2. XI.	9	...	...	...	...	...	...	...	...	...	...	...	,,
,, ...	,,	3	...	—	...	...	...	...	...	...	...	...	...	
,, ...	,,	2	...	...	+	...	...	...	...	...	...	...	...	Mostly Calanus.
,, ...	,,	3	...	...	...	...	...	...	...	+	...	...	...	
,, ...	,,	1	...	—	+	...	...	...	...	...	...	...	...	
,, ...	3. XI.	4	...	...	...	...	...	...	...	...	...	...	...	All empty.
,, ...	,,	7	...	...	+	...	...	...	...	...	...	...	...	
,, ...	,,	1	...	+	...	...	...	...	...	...	...	...	...	Including Siriella.
Sound of Kilbrannan, . .	4. XI.	1	...	...	+	...	...	...	...	+	...	...	...	
,, ...	,,	4	...	+	+	...	...	...	...	...	...	...	...	13 empty.
,, ...	,,	5	...	...	+	...	...	...	...	...	...	...	...	Including Calanus.
,, ...	,,	1	...	×	...	...	...	...	...	...	...	...	...	
,, ...	,,	3	...	...	...	...	...	...	...	+	...	...	...	
Sound of Bute, . . .	16. XI.	36	...	...	...	...	...	...	...	...	...	...	...	All empty.
,, ...	18. XI.	12	...	...	...	...	...	...	...	...	...	...	...	,,
,, ...	19. XI.	21	...	...	...	...	...	...	...	...	...	...	...	,,

Explanation of Symbols.— × = abundant ; + = medium quantity ; — = very few.

APPENDIX F.—TABLE I.—*Continued.*

Locality.	Date.	No. of Stomachs.	Hyperiidæ.	Schizopods.	Copepods.	Ostracods.	Larval Crustacea, mostly Zoea and Megalops.	Sagitta.	Other Annelids.	Young Herring and Sprats.	Sand Eels.	Fish Ova.	Mollusca.	Remarks.
GIRVAN DISTRICT.														
Off Maidens,	18. II.	12	...	×	...	...	...	...	...	...	...	...	...	Nyctiphanes.
Girvan,	20. II.	2	...	†	...	...	...	...	...	...	...	...	...	”
Ballantrae,	19. III.	2	...	...	...	...	...	...	...	×	...	...	...	Larval Herring.
”	”	2	...	...	...	...	...	...	...	×	...	×	...	” and ova.
Ailsa Craig,	2. V.	4	...	...	×	...	...	...	...	...	...	...	...	
Girvan,	”	2	...	...	×	...	▬	...	...	...	...	...	...	
”	4. V.	2	...	...	×	...	...	...	...	...	...	...	...	Calanus.
”	16. V.	3	...	×	...	...	...	...	...	...	...	...	...	
”	21. V.	10	...	...	×	...	...	...	...	×	...	...	...	
Ailsa Craig,	”	3	...	...	×	...	...	...	...	...	...	...	...	Calanus finmarchicus.
”	”	2	...	...	×	...	†	...	...	...	...	...	...	Young Hippolyte.
Girvan,	23. V.	3	...	...	×	...	...	...	...	...	...	...	...	
”	31. V.	3	...	...	×	...	...	...	...	...	...	...	...	
”	12. VI.	5	...	†*	×	...	...	...	...	...	...	...	...	* Young Nyctiphanes.
”	26. XI.	2	...	†	...	...	...	...	...	...	...	...	...	Young Euphausiidæ.
”	XII.	1	...	†	...	...	...	...	...	...	...	...	...	Nyctiphanes.
”	”	1	...	†	...	...	...	...	...	...	...	...	...	Young Euphausiidæ.

Explanation of Symbols.—× = abundant; † = medium quantity; ▬ = very few.

On reaching the Wick district, the diminution in the supply of *Hyperia* is still more marked. This species is here most frequent during December and January, in February the supply is small, while in March the herring have already ceased feeding on *Hyperia.* This species does not, however, appear to form such an important part of the herring's food in the Wick district at any time, as it does in the waters south of Peterhead.

Our statistics from the Shetland district are not very complete. Twenty-one stomachs were collected in the month of April, and in these *Hyperia* was altogether absent. In a single stomach from Noss in June a fair number of *Hyperiæ* occurred.

Turning now our attention to the West Coast, it will be seen that not a single specimen of *Hyperia* has been found in any of the stomachs examined. It is true that the majority of the fishing on the West Coast takes place between the months of April and October, at a time in fact when the East Coast herring are not feeding on this form. Still we have statistics from the Girvan district in December, February, and March; and from the Ullapool district in December and March, so that if *Hyperia* really occurred in these districts in considerable numbers, it should be found at this time. We are, however, of opinion that *Hyperia* cannot be a common form on the West Coast. In Loch Fyne we have only once met with this species, and it then occurred in the cavity of a medusa, which had been stranded on the beach.

From an economic point of view, the absence of *Hyperia* in the stomachs of the West Coast herring is very interesting. It is evident that we must look to other forms to supply the food of the herring on the West Coast during its period of growth.

A few other species of amphipods have been met with on two or three occasions, but have not been identified.

Schizopods.

We have met with at least two species included in this group which supply a considerable portion of the herrings' food during certain months of the year. These are *Nyctiphanes norvegica* and *Boreophausia raschii,* the former occurring in great numbers all around our coasts, while the latter appears to be rarer and more local in its distribution. We are indebted to the Rev. Canon Norman for the identification of both these species, who contributes a paper on these and other interesting crustacea to the present report. *Nyctiphanes norvegica* G. O. Sars. is the *Thysanopoda norvegica* of M. Sars., and has already been recognised as an important herring food by Mr Sim and others. *Boreophausia raschii* is an allied form, which has only quite recently been recognised as British.

Nyctiphanes norvegica.—This species has occurred with greater or less frequency in the material examined from all the districts excepting Berwick. It is probable that *Nyctiphanes* really occurs in the Berwick district also. and that we have failed to find it there, simply because our statistics refer only to the months of July, August, and September. The relative frequency of Hyperiidæ and Schizopods in the herrings' stomachs is well brought out in the table included in the present report. A comparison of the two columns devoted to these groups brings out several interesting points. With reference to the food of the East Coast herring, it may be stated generally that the relative frequency of *Hyperia* and *Nyctiphanes* depends on the month during which the fish were captured. *Hyperia* is extremely abundant during January and February, and the stock then gradually diminishes, or at anyrate the herring do not feed on this form to such a great extent after that time. The diminution in quantity is

generally gradual. At the time *Hyperia* occurs in immense numbers *Nyctiphanes* does not appear to be common. As the *Hyperiæ* become less frequent in the herrings' stomachs *Nyctiphanes* is found in ever increasing quantity until it has entirely, or almost entirely, taken the place of the former. In short, the quantity of the one appears to be inversely proportional to that of the other. This will be well seen from a comparison of the statistics given for the Forth. This relationship appears to be carried out still further. Just as *Hyperia* was found to be abundant south of Peterhead and to diminish gradually in numbers further north, so the distribution of *Nyctiphanes* appears to be the very reverse. We have found this species in greatest numbers in herring from the Wick district, while in the more southern districts it is certainly not so common. On the West Coast *Nyctiphanes* has been met with from Stornoway to Girvan, but not usually in large numbers. In the Stornoway district it is abundant in April, but the number diminishes considerably in May and June. In the Loch Broom district from October to December, and also in March, the herring feed almost entirely on this and other Schizopods. We have no information from that district in January and February. In Loch Fyne this form does not appear to be abundant at any time. A few have been met with occasionally in May and June, while the species appears to be more frequent in the autumn. It should be stated that we failed to recognise schizopods in the herrings' stomachs from Loch Fyne in 1885 until the autumn. The records of these forms for the summer were obtained from material supplied by the Fishery Officer in 1884. In the Girvan district *Nyctiphanes* occurs in about the same proportion during the different months as on the East Coast. In November and December it was found to be fairly common, the greatest numbers were met with in February, while in May only very few were found.

Boreophausia Raschii.—This species was not distinguished from the preceding in the earlier part of our inquiry, so that it may possibly occur more frequently than is shown by the statistics. It has been met with in the stomachs of the herring from the Stonehaven district in January and June, in moderate quantities. In the Stornoway district it has occurred in the month of June. In Loch Broom this species appears to be very common, and has occurred in large quantities in the stomachs examined during October and November. We have also found it in small quantities in Loch Fyne.

Copepods.

As a general rule, it may be stated that the copepods supply the principal food of the herring during the summer months. The herring caught during the summer fishery on the East Coast are usually ripe fish which take little or no food. The proportion of stomachs containing food varies considerably from day to day, and the contents usually consist of copepods in small quantities. On the West Coast, however, most food is taken during the summer months, when the herring gorge themselves with copepods. It thus happens that as the herring take more food during the summer in some districts than in others, the relative abundance of the different forms cannot be accurately estimated from a study of the stomachs.

The contents of a large number of the stomachs examined from the Berwick district, in July, August, and September, consisted chiefly of copepods.

The statistics for the Anstruther district refer only to the winter and spring months, during which time copepods do not occur in great quantities. On the 27th of December a large number of copepods are recorded as

occurring in the Forth, but we cannot vouch for the accuracy of this statement, as we had not an opportunity of examining the material. In the area extending from Aberdeen to Wick so small a percentage of stomachs contained food during the summer that an unusually large number had to be examined in order to obtain any reliable data. Of these, only the stomachs which contained food appear in the statistics now given.

On the West Coast, the bulk of the herring take most food during the summer months, so that copepods come to form the most important food on that coast.

During the months of May and June the food in the Stornoway district consists of copepods mixed with about an equal quantity of schizopods, many of which are young forms.

The stomachs examined from the Loch Broom district were all obtained during the colder months, and, as might be expected, no copepods were found in them.

A glance at the statistics given for Loch Fyne will show what an important part is played by the copepods in that district. In April, May, and June, the food consists almost solely of copepods. During this time almost every herring is perfectly gorged with copepods, and the richness of this food has undoubtedly a great effect on the quality of the fish. During the months of July and August many stomachs are empty, but the food still consists of copepods, the supply of which has, however, greatly diminished. The herring still continue to feed on copepods as they leave Loch Fyne, and a few stomachs may be found which contain these forms up to November. From the month of September onwards, the schizopods partly replace the copepods in the herrings' stomachs. Combining the statistics for the Girvan district with those for Loch Fyne, it seems probable that the supply of copepods practically ceases in November and that these forms are not met with again until April.

An attempt has been made to identify the various species of copepods met with in the herrings' stomachs from all parts of the coast, but owing to the minuteness of the forms this task is rendered almost impossible when the food is partly digested. During the past season a considerable amount of attention has been paid to the copepods of Loch Fyne, and twenty-eight species have already been obtained (see Appendix, p. 147). Of these only seven have as yet been met with in the stomachs of the herring; they are as follows:—

Calanus finmarchicus appears in immense quantities when the herring enter Loch Fyne in April, and constitutes the bulk of their food until the end of June. The supply of this and other common species then diminishes rapidly, but a few may be obtained throughout the year.

This species appears to be common all around our coasts, and is certainly the most frequent form in the herrings' stomachs both on the West and on the East Coasts.

Temora longicornis.—This is a common form but not nearly so abundant as the preceding. It is, however, generally distributed, and we have obtained it from many localities. According to G. O. Sars, *Calanus* and *Temora* exist in myriads off the Loffoden Islands, and there also form almost the sole food of the herring during the spring and summer.

Pseudocalanus.—We have met with this species frequently, more particularly from the Stornoway and Loch Fyne districts.

Centropages typicus.—Frequent in Loch Fyne during the summer, and forms a part of the food of the herring in the Clyde Estuary, in the Stornoway district, and also on the East Coast.

Centropages hamatus.—Frequent in Loch Fyne. Has been found in herrings' stomachs from Loch Fyne and the Stornoway district.

Dias longiremus.—Occurs in fair quantity in Loch Fyne, and has frequently been associated with other copepods in the material examined at Tarbert.

Metridia armata.—This species occurs in small quantities in Loch Fyne during the summer, and we have once or twice met with it as food of the herring.

Other Groups of Crustacea.

The *Ostracoda* have not often been met with as herring food, but they are so small that they may be easily overlooked, particularly in material preserved in spirit. Our only records are from the Wick district, and the species have not been identified.

Larval decapods.—The zoea and megalopa stages of many species of decapods are frequently found in the stomachs of the herring. They occur chiefly during the spring and summer all around our coasts, and are usually associated with the copepods. Our knowledge of these larval forms is, as yet, too incomplete to admit of an identification of the species. As a rule, only a few specimens are obtained from a single stomach, but occasionally, as in the Sound of Kilbrannan in April, we have found zoeæ in considerable quantities. Young *Carcini* and *Virbius varians* have also occurred occasionally, but cannot be considered part of the normal food supply. *Evadne Nordmanni* has also been found in fair abundance in Loch Fyne, and sometimes occurs along with other pelagic food forms.

Annelids.

Sagitta occurs in great quantities on the East Coast, and in the winter months undoubtedly forms an important part of the herrings' food. We have met with it most abundantly in material examined from the Aberdeen district. *Sagitta* is also abundant on the Ballantrae banks, and to a less extent in Loch Fyne in the spring, but we have not met with it as food of the herring in those districts.

Other forms of annelids have been met with occasionally, but the specimens have not been identified.

Fishes.

Young Herring and Sprats.—It is almost impossible to separate the young of these two species in a partly digested condition, and the following remarks on the occurrence of the two forms as food of the herring are based rather on probability than on fact:—

On the East Coast the young clupeoids, on which the adult herring feed in the winter months, are undoubtedly sprats in the estuaries, and possibly also in the other localities. The whole of the specimens examined from Dundee in January and February had been feeding only on these young forms. Those recorded from Fraserburgh in June were more probably the young of the herring. On the West Coast young clupeoids are recorded in the Stornoway district for the months of April, May, and June; sometimes in considerable quantities. These were probably all young herring, and in some cases were associated with herring ova.

In May and June herring were occasionally met with which had been feeding on the young of their own kind, and a few other instances are recorded in November. Mr Matthews has, however, recognised the sprat in the Girvan district. There is thus a possibility that some of the specimens in the Clyde estuary, which we have been accustomed to regard as larval herring may ultimately prove to be sprats.

On the Ballantrae banks the herring undoubtedly feed on their own ova and young, and the same is probably the case in other spawning districts.

The Sand-eel (Ammodytes).—In certain districts on the East Coast the herring appear occasionally to feed largely on sand-eels. At Macduff in June, four herrings were obtained which contained respectively 16, 29, 32, and 36 sand-eels; and we have another record from the same district in February. The other localities are as follows:—Burghead in February and March; Buckie in August; Wick in January and July; and Lybster in March. We have no record of the occurrence of sand-eels as food of the West Coast herring; indeed, the coast generally is too rocky for sand eels to be plentiful, though they occur locally in considerable numbers. The only other kind of fish we have observed were from Wick in February, when two stomachs were found to contain young *Gadidæ.*

Fish Ova.

The ova which are found from time to time as herring food, fall naturally into two groups, the pelagic and non-pelagic forms.

The pelagic ova have been obtained chiefly in the spring and summer, and are frequently associated with copepods. They are in all probability the eggs of the *Gadidæ, Pleuronectidæ, Cottidæ,* and similar common fishes. The only non-pelagic ova which we have met with are those of the herring, and have been obtained during the spawning season in various localities. The chief of these, so far as our observations go, are Ballantrae in March and around the Island of May in the spring.

Mollusca.

The mollusca apparently do not contribute an important part of the food of the adult herring, though herring embryos, according to Meyer, feed largely on the free swimming stages of mollusca.

Of nine stomachs sent from Berwick on the 1st July, eight contained univalve embryos, and in six of them the quantity was considerable. A few molluscan embryos were met with in herring caught off Fraserburgh in August, and also off Wick in July. These are the only records of the occurrence of mollusca which have come under our notice, with the exception of a single specimen of a nudibranch, which occurred off Stonehaven in June. It should, however, be remarked that many molluscan embryos, which occur in great numbers, and might probably form a part of the herrings' food, could scarcely be recognised amongst a quantity of other food when preserved in spirit.

In conclusion, it may be stated that on the East Coast generally, *Hyperia, Schizopods,* and in a less degree *Sagitta,* form the constant and regular food of the herring during the winter and spring. There appear to be two principal exceptions. *First,* in certain estuaries, during January and February, the food consists almost solely of young sprats, while in other localities, chiefly in the Moray Firth, sand-eels occasionally contribute an important part of the food, both in the spring and summer. *Secondly,* on such spawning grounds as that around the Island of May in the spring, those herring which take food appear to subsist chiefly on the ova of their own kind.

During the summer months copepods form the chief food, and are often associated with other pelagic forms, such as the larval stages of decapods and fish ova. The percentage of stomachs containing food is, however, not nearly so great in the summer as in the winter and spring, and the quantity of food in each is, as a rule, comparatively small.

On the West Coast the schizopods supply the chief food of the herring during the winter months; *Hyperia* has not occurred in any of the material we have examined. During February and March at Ballantrae the chief or sole food consists of herring ova and fry, it being then the spawning period in that district. During the summer and autumn the copepods supply the all important food on the West Coast, and, so far as bulk is concerned, take the place of the Schizopods and Hyperia on the East Coast. There is here also a large admixture of other pelagic forms. In the autumn the schizopods gradually take the place of copepods as food.

On the West Coast nearly all the stomachs are distended with food from April to July, with certain exceptions, while in the autumn, winter, and spring the percentage containing food appears to be much smaller. On this account the greatest amount of food is taken at different seasons on the two coasts, and it thus happens that Hyperia and Schizopods may be regarded as constituting the most important food forms on the East, and the copepods on the West Coasts.

Calanus finmarchicus is by far the most abundant species of copepods found as herring food on both coasts, and it is probable that *Temora longicornis* comes next in importance. In the Stornoway district, however, *Pseudocalanus* and *Centropages* appear to be more abundant.

The amount of copepods found in the herrings' stomachs from the East Coast is undoubtedly considerably less than that found on the West, but we are at present unable to say whether this proportion really represents the relative abundance of this group on the two coasts or not.

II.

PRELIMINARY ACCOUNT OF THE FOOD OF THE HADDOCK. By George Brook, F.L.S.

The present account of the food of the haddock is limited to material which has been supplied by the Fishery officers of the Board. The material so supplied is very incomplete from many points of view. Altogether the contents of 90 stomachs have been examined, but more than half of these have been supplied from one district. The following are the numbers of haddocks' stomachs examined from the respective districts:—Anstruther 4, Berwick 58, Burghead 3, Cromarty 6, Helmsdale 1, Lybster 5, Montrose 7, Stonehaven 4, and Wick 2. The two stomachs sent from Wick were samples of between 70 and 80 which were examined, 'all of which contained more or less food.' It will be seen that from this list that information is entirely absent from some of the important haddock fisheries, while that supplied from all of the others, excepting Berwick, is so small that no general conclusions can be based upon it.

Again information has not been supplied at regular intervals throughout the year. This, no doubt, is to some extent unavoidable, as material can only be preserved during the period that the haddock fishery is prosecuted by the fishermen in each district. Still, taking this into account, the material supplied is not so complete as could have been wished. During the months of January, February, and March, the contents of 77 stomachs were secured, while during June, July, October, and November, the contents of only 13 were preserved. Thus from

April to December there has been scarcely any material supplied to aid in studying the various questions relating to this important subject.

Mr Thomas Scott has had charge of the identification of specimens, and I am also indebted to him for the two tables in this Report.

In the following table an endeavour has been made, first, to identify as far as possible the contents of the various stomachs; and, secondly, to show the relative frequency and quantity of the various classes of organisms in the stomachs from the different localities. It has, of course, frequently happened that the food has been too far digested to allow of its identification. It appears from notes accompanying the material that fully 200 stomachs were examined, and of these 28 were found to contain no food.

TABLE I.—Classification of the Food Material identified, giving the number of Stomachs in which each Species occurred.

Name.	No. of Stomachs in which Specimens were observed.	Remarks.
HYDROZOA—		
Sertularia, sp.,	4	Four pieces only.
ACTINOZOA—		
An Actinian,	1	Too much digested to be identified.
ECHINODERMATA—		
Ophioglypha albida (Forbes),	6	Not very many.
Amphiura filiformis (Müll),	7	,, ,,
Ophiothrix pentaphyllum (Penn.),	19	Very abundant.
Asterias aurantiaca (L.),	1	A very young specimen.
Echinus miliaris (L.),	1	Two or three young specimens.
Echinocyamus pusillus (Müll),	10	A good many specimens.
Spatangus purpureus (Leske),	1	Fragments of test.
Amphidotus cordatus (Penn),	2	,, ,,
ANNELIDA—		
Aphrodite aculeata (L.),	5	Specimens more or less digested.
Aphrodite hystrix,	1	A single specimen nearly whole.
Arenicola, sp.,	1	Specimen fragmentary.
Errantia group,	14	Much digested remains.
Tubicolous annelid,	1	Part of worm and tube.
Tubes of annelids,	2	Arenaceous tubes.
CRUSTACEA—		
Hyas coarctatus (Leach),	4	
Portunus pusillus (Leach)	1	
Portunus marmoreus (Leach)	1	Young specimen.
Pinnotheres pisum (Penn)	1	A few of fair size.
Porcellana longicornis (Penn),	1	Two specimens nearly whole.
Pagurus Bernhardus (L.),	8	Specimens more or less digested.
Pagurus ferrugineus (Norm)?	1	
Calocaris Macandreæ (Bell),	1	Two or three specimens.
A Brachyurous crab,	2	Much digested.
Galathea, sp.,	10	Very immature and fragmentary.
Crangon Allmani (Kinahan),	4	
Hippolyte spinus (Sowerby),	1	
Hippolyte, sp.,?	2	Fragmentary.
Cuma scorpioides (Mont.),	1	A number of specimens.
Amphipods,	7	
Isopod,	1	
Philamedes interpuncta (Baird),	1	

TABLE I.—*continued.*

Name.	No. of Stomachs in which Specimens were observed.	Remarks.
Balanus crenatus (Brug.),	1	Possibly attached to the carapace of a crab when swallowed.
MOLLUSCA—		
Anomia ephippium (L.),	1	Very young.
Pecten tigrinus (Müll)?	1	Young.
Nacula nitida (Sow),	1	
Cardium fasciatum (Mont)	1	Fragment.
Cardium echinatum (L.),	1	Young.
Venus gallina (L.),	1	Young.
Mactra solida (L.)	1	Some fry.
Scorbicularia alba (Wood),	1	Young.
" *nitida* Müll),	1	
Solen, sp.,	2	Fragments.
Mya, sp.,	1	"
Psammobia tellinella (Lam.),	1	Young.
Lasœa rubra (Mont.)?	1	
Chiton, sp.,	1	
Eulima bilineata (Alder),	1	Perfect shell.
Natica Alderi (Forbes),	2	Young specimens.
Buccinium undatum (L.),	2	Opercula.
Fusus, sp.,	1	Opercula, probably of F. antiquus (L.)
Pleurstoma turricula (Mont.),	1	Damaged shell.
Cylichna, sp.,	1	
Velutina lævigata (Penu),	1	
Fragments of bivalve shells,	3	
PISCES—		
Callionymus lyra,	1	Very young.
Fish remains,	7	Very much digested.
Herring ova,	4	In three specimens from May Island the stomachs were crammed with ova.

Other 19 or 20 objects were too much digested or too fragmentary to be identified.

Amongst the Echinoderms it will be noticed that the common brittle star (*Ophiothrix pentaphyllum*) occurs much more frequently than any other species. This is a very common form all along the East Coast, occurring in great numbers on the shell banks, and extending into deep water. It occurs more frequently in the haddock's stomach than any other form of food, and is undoubtedly one of the most important, both as regards the number of stomachs in which it has been found and the number of specimens in each stomach.

Ophioglypha albida and *Amphiura filiformis* have occurred on about an equal number of occasions, but not in large quantities.

Echinocyamus pusillus, which is a small deep-water form of the sea urchin group, occurs in considerable numbers, but, on account of its small size, does not form a very important part of the *bulk* of the food.

Other common forms, such as *Amphiura Chiajii*, *Ophiopholis aculeata*, and *Ophioglypha lacertosa*, have not been met with in the material examined. It is also curious to note that none of the Holothurians have been met with, although Professor M'Intosh has recorded several species as occurring both in the stomachs of the haddock and the cod.

Amongst the annelids the sea mouse (*Aphrodite*) occurs plentifully in the stomachs of the haddock, though not so frequently as in the cod.

In glancing over the list of crustacea it is interesting to note the occurrence of *Calocaris Macandreæ*, a deep-water form, which is rare around our coasts. The specimens occurred in one of the stomachs from fish captured 18 miles off the Coquet on the 26th January 1885. Dr Norman informs me that Stonehaven is the only other East Coast locality at which this form has been taken. It is principally met with in the deeper portions of Loch Fyne and at other points along the West Coast.

With the exception of *Hyas coarctatus* the *brachyurous* decapods do not occur in large numbers. The *Anomura*, on the other hand, contribute the greater portion of the crustacean food, being mainly represented by species of the genera Pagurus and Galathea. The other groups do not present any point calling for remarks here.

An examination of Table II. will show that the echinoderms form by far the greater portion of the food of the haddock. It is important, however, to note that in twelve stomachs from the Coquet in January, only a single echinoderm was found, and that the crustacea and mollusca formed in this case the bulk of the food, the annelids also not being present in the large quantity.

Amongst the echinoderms it is worthy of note that the 'star fishes,' properly so called, do not form an important part of the food of the haddock, the only specimen met with being a young specimen of an Asterias, probably the *A. aurantiaca.* This may, no doubt, partly be accounted for from the fact that the commoner species of star fish are mainly littoral in their habit, but this cannot be the only reason. There must be some other objection to the use of the star fish group as food for the haddock and other fishes, as they occur in considerable quantities in the parts frequented by these fishes. For instance, the range of the common star fish *Asterias rubens*, of *A. violacea* and other forms, extends some distance beyond the estuary of the Forth, St Andrew's Bay, &c. They are probably found up to a considerable depth all along the east coast. The frequent occurrence of *Echinocyamus pusillus*, a very small species of the 'sea urchin' group is also worthy of note. So far as the material at my disposal is concerned, the *Crustacea* rank next in importance in the food supply of the haddock. At least seventeen species have been found in the ninety stomachs examined, and there are several which are too much digested to allow of identification. Amongst the crustacea the hermit crabs (*Pagurus*) and squat lobsters (*Galathea*) are of by far the most frequent occurrence. Next in importance come the amphipods, but of these no species have been identified. *Hyas coarctatus*, one of the spider crabs, was found in four stomachs, while *Hyas araneus*, the common shore form, was not met with at all. *Hyas coarctatus* is a smaller species, and almost entirely takes the place of *H. araneus* in deeper water. This fact, doubtless, accounts to a great extent for the absence of the shore form in the stomachs examined. A similar relation appears to exist between the common shrimp *Crangon vulgaris*, and its ally *C. Allmani*. The latter almost entirely replaces the former in deep water. This relationship is found to be carried out in the present statistics. *Crangon Allmani* occurred in four stomachs, while *C. vulgaris* was not met with at all. The worms and molluscs come next in importance as food material, each supplying about an equal share. With regard to the annelids it will be seen that the sea mouse (*Aphrodite*) and other 'errant annelids' are of most frequent occurrence. The majority of the annelida are, however, difficult to identify unless in a fresh condition.

A study of the molluscan contents of the stomachs brings out two

TABLE II., showing the Localities and the approximate Number of Specimens of each Group of Food contained in the stomachs examined.

LOCALITY.	Distance from shore.	Date.	Number of stomachs.	Hydrozoa.	Actinozoa.	Echinodermata.	Annelids.	Crustacea.	Mollusca.	Pisces.	Herring ova.	REMARKS.
Helmsdale, ...	7 m. off	Jan. 17	1	...	...	2	..	...	1	1	...	
Berwick, ...	4 m. off	„ 21	8	1	1?	numerous	6	numerous	2	4 or 5	...	
Lybster, ...	½ to 1 m. off	„ 26	2	2	...	numerous	...	2	1	...	...	
Coquet, ...	18 m. off	„ 26	12	...	...	1	a few	numerous	numerous	1	6	One stomach contained the rare *Calocaris Macandreæ.*
Wick, ...	...	„ 27	2	...	...	9	1	a few	2	1	...	Between 70 and 80 others examined by F. O., 'all of which contained more or less food.'
Montrose, ...	7 to 8 m. S.E.	„ 29	5	...	...	4	1	9	4	...	...	
Stonehaven, . . .	4 m. S.E.	„ 31	2	...	...	9	1	1	...	...	...	
Swiney, ...	2 m. off	Feb. 13	3	...	...	numerous	...	a few	...	...	...	
Eyemouth, ...	10 m. E.N.E.	„ 20	1	...	...	4	1 or 2	3	...	...	...	
Eyemouth, ...	10 m. E.N.E.	„ 22	9	...	...	numerous	...	5	4	1 or 2	...	
Stonehaven, . . .	1½ m. off	„ 25	2	...	...	1	1	5	...	...	...	
May Island, . . .	10 m. off	Mar. 4	1	...	...	1	2	1	...	...	...	
May Island, . . .	Near	„ 24	4	...	...	...	...	...	...	...	great quantity.	Caught on herring spawning ground.
Berwick, ...	20 m. off	„ 24	17	...	...	numerous	9	10	3	...	...	
Eyemouth, ...	17 m. N.E.	„ 31	1	1	...	numerous	4	10	8	...	...	
Tarbet Ness, . . .	3 m. off	June 26	5	...	...	numerous	...	1	...	4	...	
Burghead, ...	4 m. off	July 2	1	...	...	1	...	2	...	...	...	
Burghead, ...	5 m. off	„ 7	2	...	...	4	1	1	...	...	...	
Buckie, ...	15 m. off	Oct. 15	2	...	...	numerous	...	numerous	numerous	...	...	
Buckie, ...	35 m. N.E.	„ 17	2	...	...	numerous	...	numerous	...	...	...	
Cromarty, ...	...	Nov. 8	1	...	...	2	3	...	3	...	...	

points of interest. In the first place, the larger portion of the molluscan material consisted of either small species or the fry and young of other forms. In the second place, it is important to note that whereas twenty-one species of mollusca have been identified or allocated to their respective genera, not a single species has been found in more than two of the ninety stomachs examined. This would seem to show that although of frequent occurrence, the mollusca do not form an important part of the haddocks' food so far as bulk is concerned, and that the haddock does not show any especial preference as to species.

Of the other groups of organisms which we have found in the stomach of the haddock, it may safely be stated that the *Hydrozoa* and *Actinozoa* do not form a staple portion of the food material. They occur so rarely, and in such small quantities, that they are rather to be regarded as having been accidentally swallowed with other food, and may be left out of consideration for the present.

Coming to the consideration of the fishes as a normal food of the haddock, it will be seen that the present statistics do not supply much information. Fish remains, which were too much digested to allow of identification, were found in seven stomachs. A young specimen of the Dragonet (*Callionymus lyra*) was the only other species that could be recognised. One thing, however, these statistics do show, namely, that as compared with the cod, the fish diet of the haddock is not an important item.

Record is also made of the occurrence of fish ova in four stomachs. As regards the ova taken from the stomach of a specimen from the Coquet, these have been doubtfully identified as those of the herring. There were only about six ova in the stomach, the greater portion of the contents consisting of Crustacea, Mollusca and a few Annelids. The other three instances refer to entirely different conditions. They are from haddock caught in the vicinity of the Island of May during the spring spawning period of the herring in that district. In these cases the stomachs were crammed with herring ova to the complete exclusion of all other kinds of food. Herring ova are evidently a great dainty, and during the period referred to immense numbers of haddock and other fishes congregate around the May for the express purpose of feeding on the ova. During the time the trawlers get large takes of haddock. The line fishermen are, however, not so successful, *partly* owing probably to the fact that the haddock refuses other kinds of food when herring ova can be obtained. Although the presence of spawning banks in the inshore waters undoubtedly attracts large numbers of white fish to their vicinity during the spawning period, it is questionable how far herring ova should be regarded as the normal food of the haddock. In any case the supply is not constant, and lasts only for a short time. On this account it appears that in studying the normal food supply of the haddock, and its bearing on the supply of fish, it is better to regard the occurrence of herring ova as local and of only secondary importance.

Unfortunately the present statistics are not sufficiently complete to allow of even a temporary answer being given to several important questions in connection with the food of the haddock. For instance, it is impossible to say how far the food varies in different districts or at different times of the year until our investigations have been extended *throughout the year*, and to as many fishing stations as possible.

Finally, it may be stated that so far as this, the first attempt, at a classification of the food of the haddock is concerned, the following general conclusions may be drawn :—

1. The Echinoderms, particularly the brittle stars and the pea urchin,

contribute an important and staple portion of the food supply all along the East Coast of Scotland.

2. The Crustacea come next in importance. The forms of most frequent occurrence, such as the hermit crabs, the squat lobsters, *Hyas coarctatus*, and several species of the shrimp tribe, are generally distributed along the East Coast.

3. The molluscan contents of the stomachs are specially characterised by the large percentage of young and immature forms.

4. The worms supply a considerable portion of the haddock's food all along the East Coast, and their nature and distribution especially require further study.

5. The haddock is not to a great extent piscivorous.

6. The haddock will, in certain districts, leave its usual feeding ground in order to feed on herring spawn when this is to be obtained.

It should be stated that in a preliminary report of this kind the conclusions arrived at can at best only have a temporary and tentative value. With further investigation these will most certainly require modification, while at the same time their extension and elaboration will doubtless teach us more of the habits and migrations of the food fishes.

III.

PRELIMINARY REPORT ON THE FOOD OF THE COD. By GEORGE BROOK, F.L.S.

The present report gives an account of the contents of about 300 stomachs of the cod. In a large number of cases the stomachs containing food have been forwarded to the Central Laboratory preserved in spirit; in other cases lists of the contents of a large number of stomachs have been supplied by the Fishery officers. The information supplied by the Board's officers at Anstruther, Berwick, and Girvan is especially worthy of mention. In these cases, however, it is only possible to indicate here the groups to which food material belonged, as in most cases the species were not identified. With the exception of information from Girvan and a single specimen from Lewis, the whole of the material has been supplied from the East Coast. We have no information as to the food of the cod in the latter part of the year, the whole of the statistics being obtained from January to June inclusive. Mr Thomas Scott has identified the majority of the specimens included in this report, and I am also indebted to him for the tables.

The cod is well known for its voracious appetite, and also for the remarkable variety of its food. Dr Day has already called attention to a number of cases in which objects have been found in stomachs of the cod which were not marine forms: Two cases of this class have come under our notice during the past year. In a cod's stomach from Lybster part of a sea-fowl was found, probably a guillemot. The contents of this stomach were remarkable. There were representatives of all the classes of organisms which are tabulated in the present report. The other stomach was from Berwick, and contained a whole specimen of one of the larks, probably the meadow pipit. The only other contents in this stomach were the partly-digested remains of two or three hermit crabs (*Pagurus Bernhardus*). Such cases, interesting though they may be as curiosities, only show the omnivorous appetite of the cod, and do not aid us in studying the normal food supply. According to Professor Brown Goode and others

who took part in the discussion on Dr Day's paper on 'The Food of 'Fishes,'* it appears that the cod restricts itself almost entirely to one kind of food during the time that it remains on some of the large fishing banks off the American and Norwegian coasts.

Thus, for instance, during the Labrador fishing, the cod feed almost entirely on capelin (*Mallotus villosus*); a similar state of things is found on the coast of Norway. When on the great banks, the cod feeds almost entirely on the immense shoals of herring collected there. In the winter fishing off the New England coast clams are used as bait, because the cod are then known to be feeding at the bottom, and a molluscan diet is found to be the most acceptable. Such observations undoubtedly point to the conclusion that the migrations of the cod are to a large extent dependent on the proper supply of food. It further appears that a particular class of food which may be much in demand at one season of the year is not at all sought after at another; in other words, that the cod in its migrations not only changes its food through necessity, but that it shows a preference for this change. How far the migrations may be brought about by a desire for a change of diet is a question which at the present cannot receive a satisfactory answer. In connection with this subject an interesting observation has been reported by the Fishery officer at Anstruther. It is well known that herring forms, at certain seasons at least, a very important part of the food of the cod and other fishes. On this account herring are used as bait in many fish centres whenever they are procurable. Yet it appears from Mr Mair's account that, in spite of an abundance of herring, the cod may seek other food. The following is an extract from Mr Mair's letter, dated July 31, 1885:—'Herring were 'plentiful on the distant cod-fishing ground in spring and summer during 'the period of the cod fishing, but herring were rarely met with in the 'cods' stomachs; and any stray herring found were most likely the bait by 'which the fish had been caught. Towards the end of the cod-fishing 'season, however, I was informed by one curer of a cod's stomach with 31 'herring in it; and another curer had met with one containing 27 herrings. 'These were exceptional cases.' On the other hand, on the West Coast the cod appears to have been feeding principally on herring during a part at least of this time. On the 8th of April 1885 Mr Wilson, Fishery officer at Girvan, sent in the following report:—'From the 1st January to the '26th March all the stomachs of cod (and saithe) examined contained from '5 to 8, 10, and up to 17 herrings. From 26th March to 1st April the 'stomachs contained principally herring spawn. From 3rd to 6th of April 'some of the stomachs contained cray and shell fish; but most were empty. 'On the 7th and 8th of April the stomachs were altogether empty. 'Herring appear to have left the ground about the 26th March; the cod 'then fed on herring spawn. After the 1st April the spawn must have 'quickened and floated, as none was found in the stomach of the cod, which 'then fed on ground shellfish.' In reference to the absence of food in the stomachs of the cod on the west coast after the beginning of April, it should be noted that in this district the cod themselves spawn about this time; and it is usual for the fish to refuse food during the spawning season. During the winter codfishery in the Anstruther district, herring form a considerable part of the fish's food

With these exceptions, we have not had any evidence yet brought under our notice to show that around the Scotch coast the cod does not at all times partake of a most varied diet. The following table shows the classified contents of between two and three hundred stomachs:—

* Conferences held in connection with the International Fisheries Exhibition, London, 1883. Pt. III.

TABLE I.

List of Species.	No. of Stomachs in which Specimens occurred.	Remarks.
HYDROZOA—		
Sertularia, sp.,	12	
ECHINODERMATA—		
Ophiopholis aculeata (O. F. Müll),	3	
Ophiothrix pentaphyllum (Pen),	7	Abundant.
Ophioglypha albida (Forbes),	1	
Echinocyamus pusillus (Müll.),	2	
"Starfishes," probably all Ophiuroids and not Asteroids,	17	Reported by the Fishery officers.
ANNELIDA—		
Aphrodite aculeata (L.),	21	
Aphrodite, sp.,	37	Specimens very much broken.
Annelid remains,	9	Probably Errantia.
CRUSTACEA—		
Hyas coarctatus (Leach),	32	Abundant.
Cancer pagurus (L.),	1	A fair-sized specimen.
Carcinus mœnas (L.),	1	Only one specimen.
Portunus marmorcus,	1	
,, *pusillus* (Leach),	2	
Atelecyclus septemdentatus (Mont.),	4	Broken.
Lithodes maia (L.),	1	Good-sized specimen.
Pagurus Bernhardus (L.),	18	Many; some being large; all more or less broken.
Porcellana longicornis (L.),	2	Nearly perfect.
Galathea squamifera (Mont.),	5	Much broken.
,, *strigosa* (L.),	2	Specimens fairly complete.
,, sp.,	4	Fragmentary.
Nephrops norvegicus (L.),	4	Claws and fragments.
Crangon Allmanni (Kinahan),	10	
,, sp.,	6	Specimens fragmentary.
Virbius (Hippolyte) varians (Leach),	2	
Pandalus annulicornis (Leach),	4	
"Crabs" and "spider crabs,"	48	Reported by Fishery officers.
"Shrimps" and "prawns,"	12	
Cirolana hirtipes ? (M. Edw.),	1	An isopod.
Balanus crenatus,	3	Mostly fragments.
Pycnogonum littorale,	1	A good many specimens.
MOLLUSCA—		
Anomia ephippium (L.),	3	
Mytilus modiolarius (L.),	3	Fragments.
Cardium echinatum (L.),	1	Crushed valves.
Cyprina islandica (L.),	1	Fragments.
Astarte sulcata (Da Costa),	1	Single valve.
Venus exoleta (L.),	1	Single valve; half grown.
Mactra solida (L.),	1	Half grown.
Solen, sp.,	4	Fragments.
Buccinum undatum ? (L.).	4	Opercula.
Fusus antiquus ? (L.),	3	Opercula.
,, *propinquus* (Alder),	2	Shells damaged.
"Whelks" and "other shellfish,"	13	Reported by Fishery officers.
Aplysia punctata (Cuvier),	1	
Eledone cirrosa (Lamk.).	2	Good size.
PISCES—		
Trigla, sp. (Gurnard),	4	Young.
Gadus æglifinus (Haddock),	45	Some 12 in. long,
Gadus merlangus (Whiting),	12	Reported by Fishery officer, Berwick.
Molva vulgaris (Ling),	4	Small.
Ammodytes, sp. (Sandeel),	3	Reported by Fishery officers.
Hippoglossus vulgaris (Halibut),	1	Reported by Fishery officer.

TABLE I.—*continued.*

List of Species.	No. of Stomachs in which Specimens occurred.	Remarks.
PISCES—*continued*—		
Pleuronectes microcephalus, ...	2	Known locally as "Witches."
Pleuronectes flesus and possibly other species (Flounder), ...	39	Very many young specimens.
Solea, sp. (Sole)?	4	One specimen 9 in. and $3\frac{1}{2}$ in.
Centronotus gunnellus (Butterfish), . .	1	
Callionymus lyra (Dragonet), ...	4	Very young specimens.
Clupea harengus (Herring), ...	25	Some 10, 12, and 13 in. long.
Conger? (Eel), ...	3	Reported by Fishery officer.
Raia, sp. (Skate), ...	2	
"White fish" and "small fish," . . .	60	Reported by Fishery officers.
Fish remains, ...	36	Often only bones.
AVES—		
Part of sea-fowl, probably a Guillemot, .	1	
Anthus, sp. Meadow pipit, ...	1	Only slightly digested.

In reviewing the classified contents of the stomachs examined, it will be well to call attention to certain interesting points. The hydroids may, as in the case of the haddock, be regarded as supplying an unimportant, and probably to some extent, accidental part of the cod's food. With regard to the Echinoderms, attention may again be called to the fact that the 'brittle stars' contribute by far the greater portion of the food supplied by this class.

There were no asteroids (star fishes) in the stomachs which we have examined, and it is extremely probable that the food grouped as 'star fishes' by the Fishery officers belongs almost entirely to the 'brittle stars,' and not to the 'star fishes' proper. *Echinocyamus pusillus* is the only representative of the 'Sea Urchin' group which we have met with in the stomachs examined. Neither have we met with the more friable heart urchins, although two species were met with in the haddocks' stomachs. Of the Ophiuroids, *Ophiothrix pentaphyllum* has proved to be far the most frequent, and sometimes occurs in large quantities. The other brittle stars, although they may frequently be met with, are not found in large quantities.

On comparing the list of Echinoderms here given with that in forming the food of the haddock (see *ante*, p. 128), it will be noticed that *Ophiopholis aculeata* has been met with amongst the food of the cod, but not in the haddock's stomach, while the reverse is true of *Amphiura filiformis*. Coming to the Annelids, it is interesting to note that the sea mouse (*Aphrodite*) supplies nearly the whole of the food derived from this group of animals. Of 67 stomachs containing annelid food material, the sea-mouse was found in 58. In 21 cases the species was identified as *Aphrodite aculeata*. Without doubt this is the common form, though *A. hystrix* may occur occasionally.

In the list of Decapod Crustacea six species are given which were not found in the haddock's food. These are *Cancer pagurus*, *Carcinus mœnas*, *Atelecyclus septem dentatus*, *Lithodes maia*, *Galathea strigosa*, and *Nephrops norvegicus*. Most of these, however, do not occur frequently, and, with the exception of *Nephrops* and *Atelecyclus*, cannot be regarded as supplying an important or constant part of the cod's food. *Hyas araneus*

is, as was the case in the haddock examined, entirely absent, while its deep water congener, *H. coarctatus*, is extremely abundant.

Pycnogonum littorale, which we have not met with in the haddocks' stomachs examined, was found plentifully in one stomach of the cod, from Berwick in May last. This species is mainly littoral in its habit, and is abundant under stones between tidemarks. In such a habitat it would scarcely appear available as food for the cod, and it would be interesting to know how the specimens here recorded were obtained. The list of Mollusca, given in Table I., is rather a short one, shorter indeed than might have been expected, judging from the omnivorous reputation of the cod. We have only identified six species, which have also occurred in the stomachs of the haddock. Of these *Anomia*, *Solen*, *Buccinum*, and *Fusus*, appear to be the most frequeut molluscan forms in both cases. The sea hare (*Aplysia*) has been met with in only one stomach from Stornoway. Of the squids, which at times form an important part of the food of the cod and other Gadidæ, we have as yet only met with one species (*Eledone*) in the stomachs of the cod. Professor M'Intosh has recorded both this species and *Loligo* as of frequent occurrence in the stomachs of cod and haddock captured at St Andrews. It may generally be stated that so far as the material at our disposal goes, the molluscan food of the cod consists in the main of mature or well-grown forms, whereas the haddock appears to prefer the fry and immature individuals.

A glance at the list of fishes in Table I. will show what an important part these play in the food of the cod, yet the list of species is by no means a long one. Haddock, flounders, and herring are particularly abundant, while other species do not appear to contribute in an important degree to the food supply. We are indebted to the Fishery officers for the greater part of our statistics included in the list of fishes. It is therefore possible that species which are in reality distinct have been grouped together in some cases, under a common English name. For instance, flounders were found in 39 stomachs, but it is probable that *all* the specimens included under this head were not *Pleuronectes flesus*. At any rate, such common forms as *Pleuronectes platessa* and *P. limanda* may have formed part of their number. *Pleuronectes microcephalus* (the long dab) has been recorded in the stomach of the cod by the Fishery officer at Berwick. This species is not nearly so plentiful as some of the other flat fishes. Specimens of this form are locally known as 'Witches,' a name which appears to be commonly applied to this species along the East Coast of Scotland, though it is not included in Dr Day's list of local names. The only particulars we have as to the frequency of the whiting as food of the cod have been supplied by the Fishery officer at Berwick. In other cases the whiting has probably been included under the heading 'Haddock' in the statistics supplied. Although these two species may be distinguished at a glance in the fresh condition, they are not so easily identified when partly digested. The dark 'thumb-mark' behind the pectoral fins in the haddock, by which this species is at once recognised, soon disappears under the influence of the digestive fluids, as does also the barbel. The shape of the two species is undoubtedly different, but even this is not a safe guide when the fish remains are much digested.

It may, however, be safely stated that the whiting forms a more important part of the food of the cod than the particulars here given would lead one to suppose. It is probable also that both haddock and whiting, and perhaps other *Gadidæ* are included under the heading 'White Fish' and 'Small Fish.'

APPENDIX F.—TABLE II.

Locality.	Distance from shore.	Date.	Number of stomachs.	Hydrozoa.	Echinodermata.	Annelida (mostly sea mice).	Crustacea.	Mollusca.	Pisces.	Fish ova.	Aves.	Remarks.
Berwick,	Caught by trawlers off the Berwick and Northumberland coast. Examined by John Doull, Fishery officer.	January 20 to January 29.	1						2			
"			1				2 & remains					Hyas and remains of Mactura.
"			1						7			
"			1				much digested remains	2 whelks	7			
"			1						1			Young Molva vulgaris.
"			1						6			
"			1		several		remnants		2			
"			1				7	1 large whelk remains				
"			1									
"			1				remains	2*	2			* Cephalopods.
"			1						several			
"			1				remains		1			
"			1						3			
"			1				several					
"			1						several			
"			1						5			
"			1					1				
"			1				1					Hyas.
"			1						6			
"			1				8		2			2 Ling 4 in. long.
"			1					1	1			
"			1				remains					
"			1				6					
"			1						3			
"			1						2			
"			1				remains					

APPENDIX F.—TABLE II.—*Continued.*

Locality.	Distance from shore.	Date.	Number of stomachs.	Hydrozoa.	Echinodermata.	Annelida (mostly sea mice).	Crustacea.	Mollusca.	Pisces.	Fish ova.	Aves.	Remarks.
Berwick,	see *ante*	see *ante*	1	..	..	..	1	..	several	..	..	
,,	,,	,,	1	..	..	..	1	..	..	..	..	
,,	Caught by trawlers 18 miles north of St Abb's Head. Examined by Fishery officer.	February 25.	1	..	..	..	12	..	..	..	..	Pagurus.
,,			1	..	..	..	1	1	..	..	..	
,,			1	..	..	..	..	..	2	..	..	Pleuronectes microcephalus.
,,			1	..	..	1	8	..	..	..	..	
,,			1	..	..	..	few	..	1	..	..	
,,			1	..	..	..	..	..	1	..	..	
,,			1	..	..	few	1	..	3	..	..	
,,			1	..	..	..	..	1	16	..	..	
,,			1	..	..	..	remains	..	few	..	..	
,,			1	..	..	..	..	..	2	..	..	
,,			1	..	..	2	1	..	..	..	..	
,,			1	..	..	..	4	..	..	..	..	
,,			1	..	..	1	1	..	4	..	..	
,,			1	..	..	2	several	..	..	..	..	
,,			1	..	..	..	..	..	1	..	..	
,,			1	..	..	..	remains	..	1	..	..	
,,			1	..	..	..	..	..	several	..	..	
,,			1	..	..	..	1	..	..	..	..	
,,	Caught by line fishermen 5 miles off Berwick.		1	..	..	..	..	..	1	..	..	Sand eel.
,,			1	..	..	..	1	..	..	..	..	
,,			1	..	..	..	sev'l small	..	..	..	..	
,,			1	..	1	..	remains	..	..	..	..	
,,			1	..	..	..	1	..	..	..	..	Contained a stone.
,,			1	..	..	3*	..	..	..	..	..	*Lugworms and haddock hook.
,,			1	..	..	..	small crabs	..	..	..	..	
,,			1	..	..	..	..	2	..	..	..	
,,			1	..	..	..	..	remains	..	..	..	

APPENDIX F.—TABLE II.—*Continued.*

Locality.	Distance from shore.	Date.	Number of stomachs.	Hydrozoa.	Echinodermata.	Annelida (mostly sea mice).	Crustacea.	Mollusca.	Pisces.	Fish ova.	Aves.	Remarks.
Berwick, .	Caught by line fishermen 5 miles off Berwick.	February 25.	1	.	.	.	.	.	1	.	.	
,, .			1	.	.	.	1	.	1	.	.	
,, .			1	.	several	.	.	.	.	.	.	
,, .			1	.	.	.	4	.	.	.	.	
,, .			1	.	.	.	1	.	1	.	.	
,, .			1	.	.	.	1	.	.	.	.	
,, .			1	.	.	.	several	.	.	.	.	
,, .			1	.	several	.	1	.	.	.	.	
,, .			1	.	remains	.	remnants	.	.	.	.	
,, .			1	.	.	.	2	.	.	.	.	
,, .			1	.	.	.	1	.	1	.	.	
,, .			1	.	.	.	few	.	.	.	.	
,, .			1	.	remains	.	.	.	.	.	.	
Anstruther .	60 m. E. by N.	Mar. 16	12	.	.	48	30	1	27	.	.	
(May Island),		April 1	4	.	.	.	80	.	.	.	.	
examined by		,,	1	.	15	.	.	.	.	.	.	
Fishery officer		,,	1	.	.	.*	6	.	4	.	.	Setæ of Aphrodite.
,, .	50 m. E.N.E. of May Is.	,,	10	.	50	20	.	numerous	1	.	.	
,, .	130 m. E. of May Island.	April 17	1	.	.	.	.	.	5	.	.	
,, .	,,	,,	1	.	.	3	1	.	4	.	.	
,, .	,,	,,	1	.	.	4	.	1	5	.	.	
,, .	,,	,,	1	.	.	6	.	.	1	.	.	
,, .	,,	,,	1	.	.	.*	.	.	4	.	.	* Setæ of Aphrodite.
,, .	,,	,,	1	.	.	.	3	.	1	.	.	
,, .	,,	,,	1	.	.	6	.	.	.	.	.	
,, .	117 m. E.S.E.	April 29	1	.	.	4	17	.	1	.	.	
,, .	,,	,,	1	.	.	.	4	.	.	.	.	Large quantity fish bones.
,, .	,,	,,	1	.	.	.	4	.	1*	.	.	,,
,, .	,,	,,	1	.	.	.	.	.	3	.	.	,,

APPENDIX F.—TABLE II.—*Continued.*

Locality.	Distance from shore.	Date.	Number of stomachs.	Hydrozoa.	Echinodermata.	Annelida (mostly sea mice).	Crustacea.	Mollusca.	Pisces.	Fish ova.	Aves.	Remarks.
Anstruther,	117 m. E.S.E.	May 1	1	.	.	.	1	.	1	.	.	
,,	95 m. E. by N.	May 21	1	.	.	2	.	.	1	.	.	
,,	,,	,,	1	.	.	4	2	2	2	.	.	
,,	,,	,,	1	.	.	.	.	.	3	.	.	Haddock with hooks attached.
,,	,,	,,	1	.	.	.	.	.	5	.	.	
,,	,,	,,	1	.	.	.	.	.	4	.	.	
,,	,,	,,	1	.	.	2	.	.	1	.	.	
,,	,,	,,	1	.	.	.	4	1	.	.	.	
,,	,,	,,	1	.	.	.	.	.	4	.	.	
,,	,,	,,	1	.	.	.	1	.	2	.	.	
,,	,,	,,	1	.	.	1	.	.	3	.	.	
,,	,,	,,	3	.	.	.	.	.	4	.	.	
,,	,,	,,	1	.	.	3	.	several	.	.	.	
,,	85 m. E.S.E.	May 28	1	.	.	.	.	.	1	.	.	
,,	,,	,,	1	.	.	.	.	.	1	.	.	
,,	,,	,,	1	.	.	.	.	.	1	.	.	
,,	45 m. E.S.E. from St Abb's Head.	,,	1	.	.	1	.	.	1	.	.	
,,		,,	1	.	.	3	36	.	1	.	.	
,,		,,	1	.	.	.	.	.	3	.	.	
,,		,,	1	.	.	.	14	.	2	.	.	
,,		,,	1	.	.	.	.	.	4	.	.	
,,		,,	1	.	.	.	.	.	1	.	.	
,,		,,	1	.	several	1	.	.	1	.	.	
,,		,,	1	.	.	1	.	.	3	.	.	
,,		,,	1	.	.	3	6	.	.	.	.	
,,		,,	1	.	.	.	.	.	3	.	.	
,,		,,	1	.	.	.	.	.	2	.	.	
,,		,,	4	.	several	.	30	several	7	.	.	
,,		June 4	1	.	few	.	a few	.	.	.	.	

APPENDIX F.—TABLE II.—*Continued.*

Locality.	Distance from shore.	Date.	Number of stomachs.	Hydrozoa.	Echinodermata.	Annelida (mostly sea mice).	Crustacea.	Mollusca.	Pisces.	Fish ova.	Aves.	Remarks.
Anstruther, .		June 4	1	.	a few	.	a few	.	.	.	.	
,, .		,,	1	.	.	.	.	.	1	.	.	
,, .		,,	1	.	.	6	.	.	.	.	.	
,, .		,,	1	.	.	5	1	.	1	.	.	
,, .		,,	1	.	.	.	.	.	1	.	.	
,, .		,,	1	.	.	.	.	.	2	.	.	
,, .		,,	1	.	.	.	.	.	1	.	.	
,, .		,,	1	.	.	.	6	.	2	.	.	
,, .		,,	1	.	.	3	.	.	2	.	.	
,, .	Probably 40–50 m. E. of May Island	,,	1	.	.	.	.	.	1	.	.	18 specimens not named.
,, .		,,	1	.	.	2	.	.	1	.	.	
,, .		,,	1	.	.	.	.	.	1	.	.	
,, .		,,	1	.	.	.	.	.	6	.	.	
,, .		,,	1	.	.	.	.	.	2	.	.	
,, .		,,	1	.	.	.	6	.	.	.	.	
,, .		,,	1	.	.	.	.	.	.	.	.	1 ?
,, .		,,	1	.	.	.	.	.	1	.	.	
,, .		,,	1	.	.	.	.	.	1	.	.	
,, .		,,	1	.	.	1	.	3	1	.	.	
,, .		,,	1	.	.	4	1	.	.	.	.	
,, .		,,	3	.	.	.	.	.	3*	.	.	*(Herring) probably the bait used.
St Abb's Head,	.	Jan. 30	1	.	.	1	.	.	.	.	.	
,, .	18 m. N.	Feb. 24	2	.	.	.	.	.	18	.	.	
Berwick, .	,,	Mar. 12	2	.	.	1	1	1	a few	.	.	
,, .	,,	,, 14	3	.	.	.	8	.	4	.	.	
,, .	,,	,, 23	11	.	.	3	16	7	numerous	.	.	
,, .	,,	May 13	20	4	10	14	abundant	9	many	.	.	
St Abb's Head,	100 m. off.	,, 16	10	3	.	many	abundant	5	20	2*	.	* Eggs of skate.
Stonehaven, .	6 m. S.E.	Feb. 6	2	.	.	.	2	.	1	.	.	

APPENDIX F.—TABLE II.—*Continued.*

Locality.	Distance from shore.	Date.	Number of stomachs.	Hydrozoa.	Echinodermata.	Annelida (mostly sea mice).	Crustacea.	Mollusca.	Pisces.	Fish ova.	Aves.	Remarks.
Stonehaven, .	1 m. N.E.	Mar. 2	2	.	.	1	3	.	5	.	.	
Burghead, .	3 m. off.	Jan. 20	1	.	.	.	5	.	a few	.	.	
Lybster, .	4–5 m. off.	,, 28	1	.	.	.	.	.	several	.	.	
,, .	,,	Feb. 4	3	.	.	.	6	.	2	.	.	
,, .	,,	,, 10	2	.	.	.	2	.	2	.	.	
,, .	,,	,, 13	6	2	.	.	9	1	8	.	.	
,, .	,,	,, 14	5	1	1	1	8	.	5	.	.	
,, .	5 m. off.	,, 18	10	.	.	2	3	.	11	.	.	
,, .	,,	,, 20	9	1	1	1	2	4	3	1*	1	* Egg of skate.
,, .	6 m. S.E.	,, 26	2	.	.	1	1	.	.	.	.	
Wick, .	Sinclair's Bay.	Jan. 8	1	1	4	.	2	.	2	.	.	
Butt of Lewis,	15 m. off.	May 27	1	.	.	.	3	1	.	.	.	
Girvan, .		Jan. 22	2	.	.	.	1	.	3	.	.	
,, .		Ap. 6–18	3	.	numerous	.	2	.	2	.	.	
,, .		Jan. 1- Mar. 26	all examined	.	.	.	.	.	5 8 10 17	.	.	all Herring. (Reported by Fishery officer.)
,, .		Mar. 26– April 1	,,	.	.	.	.	.	.	large quantities	.	Herring spawn. (Reported by Fishery officer.)
,, .		April 3– April 6	,,	.	.	.	few	few	.	.	.	many empty. (Reported by Fishery officer.)
,, .		Apr. 7 & Apr. 8	,,	.	.	.	.	.	.	.	.	all empty. (Reported by Fishery officer.)
Anstruther, .	during winter herring fishing in the Firth of Forth.		,,	.	.	.	.	.	many	.	.	Fishery officer reports that cod at this time sent fresh to market, but all stomachs examined contained almost solely herring.
Berwick, .	,,	Jan.	1	.	.	.	2 or 3	.	.	.	1*	* probably a meadow pipit.

The statistics given in the above table bring out some very interesting results. The cod is undoubtedly an omnivorous feeder, and certainly makes use of a much more varied supply of food-material than is recorded in this report. To the question, 'On what will a cod feed?' the reply may be given, 'On anything, or almost anything.' The questions which we have to attempt to answer are, however, much more restricted than this one. They may be summed up in the following manner:—

1. What forms the principal food of the cod?
2. Does the chief food vary in different districts?
3. How far does the food vary in the same district at different seasons?
4. How far is a successful cod fishery in a given district dependent on the supply of any particular food?

These and allied questions must receive a definite answer before any good may be expected to be derived from legislative measures. For the present it would be premature to attempt any final answer to these questions, but it is hoped that this report may form a step towards their solution.

In the first place, let us glance over the column devoted to Echinoderms. It will be seen that this group does not supply nearly so important a proportion of the cod's food as might have been expected, judging from the frequency of many forms. The table gives detailed particulars of the contents of over 260 stomachs, while the contents of many others have been reported in a general way by several Fishery officers. Of the whole number examined, only about 40 contained any animals belonging to the class *Echinodermata.* Of 28 cods' stomachs examined at Berwick in January, only 1 contained any Echinoderms. Of 40 which were examined from the same district in February, only 5 contained any Echinoderm remains. An examination of 12 stomachs from the Anstruther district in March showed that there were no Echinoderms present. Of 27 examined from the same district in April, 16 contained no Echinoderms, while the contents of 10 others which are grouped together showed a good proportion of brittle stars. Again, of 57 stomachs examined in the same district during May and June, only 7 contained any Echinoderms. Possibly even not so many, as 4 of these are grouped together, and may not all have included representatives of this order. From the Lybster district particulars are given of the contents of 38 stomachs, taken from fish captured in January and February. Only 2 of these contained any representative of the Echinoderms, and these only one specimen each. From Wick we have only the particulars of the contents of 1 stomach, and this contained 4 Echinoderms. This case is, however, of comparatively little value, in the absence of more complete information. We have not particulars of the number of stomachs examined in the Girvan district, but only 3 are recorded as containing Echinoderms. This group cannot, therefore, judging from the present statistics, contribute largely to the sustenance of the cod. The form of most frequent occurrence is undoubtedly *Ophiothrix pentaphyllum.* The other 3 species identified have not been found to occur in considerable quantities.

Amongst the Annelids, the sea mouse (*Aphrodite*) undoubtedly contributes largely to the food supply of the cod. It occurs both frequently and in considerable numbers. The present statistics seem, however, to show that it is not taken throughout the year, and that it is only found in large numbers in limited areas.

It will be seen from Table II. that during January no sea mice were found in the stomachs of the cod found in the Berwick district, while during February a few contained sea mice. In the stomachs of the fish landed at Anstruther in March, April, May, and June, sea mice were

frequent, and formed a considerable proportion of the food, which was, however, very varied. It is also to be noted that during this time Echinoderms and sea mice were rarely to be found in the same stomach. After February, in the Berwick district, sea mice appear to have formed a fairly constant part of the food of the cod. In the early part of the year the sea mice do not appear to have been much preyed upon by the cod landed at Lybster; but the statistics from the more northern stations are insufficient to justify any close comparison.

The crustacea appear to supply the most constant and regular portion of the food supply of the cod. In by far the greater portion of the stomachs examined the crustacea group has been represented, and this frequently in association with some of the fishes. In almost every case where crustacea have not formed part of the stomach's contents, the fishes have supplied either the bulk or the whole of the food. The most noticeable exception occurred in the 10 stomachs from fish caught 50 miles E.N.E. of May Island on 1st April. These collectively contained 50 Echinoderms, 20 sea mice, no crustacea, a few mollusca, and only one fish. The number of species of crustacea preyed upon to any great extent appears to be very limited. *Hyas coarctatus*, *Pagurus*, and *Galathea*, and a few species of the shrimp tribe, seem to supply the most of the food; other forms are either local or only found occasionally.

The mollusca do not contribute largely to the food-supply of the cod. We found them to occur in only about 50 stomachs, and never in large quantities. Usually the mollusc had been digested, and only the shell remained, so that in estimating the frequency of the occurrence of mollusca it must be remembered that the presence of shells does not necessarily imply that at the last meal the cod has partaken of a molluscan diet. It must also be remembered that the hermit crabs (*Paguri*) inhabit the shells of univalves, and that many shells will doubtless be swallowed in order to secure the crabs they contain. Compared with the haddock the cod does not appear to prey so much on mollusca, nor are the species recorded so numerous.

Turning our attention to the fishes, it will be seen that in the Berwick district nearly all the stomachs examined in January contained more or less of fish remains. The records for February bring out an interesting point. The fish caught by trawlers 18 miles off St Abb's Head had been feeding almost entirely on crustacea and fishes. During the same period those landed by the line fishermen (5 miles off Berwick) seldom had any fish in their stomachs, the chief food being crustacea with a slight admixture of Echinoderms, while on only two occasions the stomachs contained solely a very limited quantity of molluscan remains. Judging from the statistics from other districts the fishes seem to supply a fairly constant portion of the food throughout the first half of the year. (We have no information as to the food of the cod after June.) It is usual in such cases for the food to consist either solely of fishes or of these and an admixture of crustacea and occasionally sea mice. The species of fishes which may be considered the normal food supply of the cod are not very varied. The *Gadidæ* (haddock, whiting, &c.), and *Pleuronectidæ* (flounders, &c.) are taken throughout the year. During the winter, in such herring-spawning districts as those of the Firth of Forth and the Ballantrae banks, the cod and haddock follow the herring to the spawning ground, and at this time their food is almost entirely confined to herring and herring ova. Judging from the observations of the Fishery officer at Anstruther it would appear that during the spring and summer the cod in the off-shore waters do not feed to any great extent on herring, although these are present in large shoals on the cod banks. The other species of

fish consumed by the cod are undoubtedly numerous, but they almost all come under the category of casuals, and are not important factors in the present inquiry.

Finally, then, the statistics brought forward in the present report appear to lead to the following conclusions—

1. The cod feeds chiefly and constantly on Crustacea, Gadidæ, and Pleuronectidæ.
2. *Aphrodite* (sea mouse) forms an important part of the food in the spring and summer in districts where this form is plentiful.
3. In the winter the cod is attracted to our shores by the large shoals of herring seeking their spawning ground, and at this time herring and herring ova form the staple food material.
4. The Echinoderms and Molluscs do not contribute an important part of the food supply.
5. The cod feeds much more on fish and much less on Echinoderms than is the case with its ally the haddock.

APPENDIX F.—No. VII.

NOTES ON THE COPEPODS OF LOCH FYNE.

By W. L. CALDERWOOD.

ON all occasions when out sailing from the Board's laboratory at Tarbert, whether amongst the fishing fleets at night or for dredging purposes by day, surface netting was engaged in, so that opportunities were not wanting for obtaining specimens of the surface forms to be met with in Loch Fyne.

When looked at with regard to the food of the herring the surface forms of greatest importance are, without doubt, the copepods, and on that account more attention has been given to them than to any other taken with the surface net.

As spring advances the copepods appear in greater and greater numbers, until, when the Loch Fyne fishing is at its height—that is to say, when the herring are at their best—the copepods are in vast abundance. At this season the prevailing species is *Calanus finmarchicus*, which occurs in sufficient numbers in certain places to colour the surface of the water. It is this species which serves as the principal food of the Loch Fyne herring during the summer.

In all twenty-eight species of copepods were obtained, not a few of which were taken by Mr Scott, who has had charge of the Tarbert laboratory during the winter months. Of that number we have only been able to identify seven in the stomachs of the Loch Fyne herring, and these were the forms which occurred in greatest abundance, showing that although a large variety of copepods abound, only those are taken which may be said to occur in shoals. The seven species identified were *Calanus finmarchicus, Metridia armata*, *Pseudocalanus elongatus*, *Dias longiremis*, *Temora longicornis*, *Centropages typicus*, and *Centropages hamatus*. Subtended is the list of the copepods, together with a short account of those features by which each species can most readily be identified under the microscope without dissection. The system of description is that adopted by Brady in his valuable monograph of British copepoda.

CALANIDÆ.

Calanus finmarchicus (Gunner).—A form large enough to be readily recognised without a microscope. It is very abundant in clear water, and is essentially pelagic in its habits. The body is elongated and ovate. Anterior antennæ 24–25 jointed, the last two joints having each a long ciliated hair. In the male the fifth pair of feet have the first and second joints of the outer branch greatly elongated, but without any marginal hairs. In the female this pair of feet is not different from the ordinary swimming feet. The terminal spines are long, oval-shaped, and unserrated. The abdomen of the male is five-, that of the female four-jointed, the tail setæ being about as long as the abdomen. The colour of this species varies very much, but it is generally yellowish; it may, however, be of a dark red, and almost pellucid. Though found throughout the year, it is in greatest abundance from May to July.

Pseudocalanus elongatus (Boeck).—Moderately abundant all through spring, summer, and autumn, both in the open sea and between tide marks. In shape it is very similar to *Calanus finmarchicus*, but of a much smaller size. In the male the anterior antennæ have only twenty joints, and the fifth pair of swimming feet are peculiar, the left foot having three, the right five joints; the abdomen has also five joints. In the female the anterior antennæ have twenty-five joints. The fifth pair of swimming feet are absent, and the abdomen has only four joints. In both male and female the caudal segments are very short, and the tail setæ scarcely equal to half the length of the abdomen. In colour it is light-red. It occurs in considerable numbers from May to July.

Metridia armata (Boeck).—Anterior antennæ nearly alike in both sexes, each joint bearing on its outer margin one or two short setæ. In the male the anterior antennæ is twenty-jointed, and hinged between the seventeenth and eighteenth joints. The swimming feet have the inner branch very short and the spines small. Fifth pair of feet cylindrical, unbranched—in the male four-, in the female three-jointed; abdomen of female three-, of male five -jointed; caudal setæ, scarcely half the length of the abdomen; length, $\frac{1}{16}$th of an inch (1·6 mm). This copepod was common during the summer.

Dias longiremis (Lilljeborg).—It is readily recognised by its antennæ, on account of their very long hairs, and the swellings at the apeces of the joints. In the male the right anterior antenna has nineteen, the left twenty-one joints, and the fifth pair of feet are four-jointed, and have strong prehensile claws. In the female both antennæ are twenty-two jointed, and the fifth feet are small and three-jointed, the terminal joints having long slender claws. The terminal spines of the ordinary swimming feet are long, slender, and sword-shaped, finely serrated on the inner border; they are peculiar from the fact that they have no small spines at their base connected to the last segment of the foot by a movable hinge, but only an arched process of that segment. This form may be of a yellow or grey colour, or it may be almost transparent. It is common in the spring and early summer.

Temora longicornis (Müller).—The body is broad in proportion to its length, and is well rounded off, and generally of a distinct brown colour. The male has twenty-one joints in its anterior antennæ, the right limb having a hinge between the eighteenth and nineteenth joints. The right fifth foot consists of a large basal joint, to which are articulated two opposable claws. The left fifth foot is three-jointed, but unbranched. In the female the anterior antennæ are twenty-five-jointed, and without

any hinge. The fifth feet are three-jointed, the last joint having four spines, two long and two short.

The spines of the ordinary swimming feet are long, and finely serrated on the inner border. They have no hairs, but have two secondary spines at their bases.

The caudal segments are extremely long and slender, and each segment carries two short spines. The terminal setæ are plumose, but not quite so long as the caudal segments. Although one of the commonest of marine copepods, it was not found in such abundance as some of the other forms; it was, however, obtained in small numbers all through the season.

Centropages typicus (Kroyer).—It is very like *C. hamatus*, the differences being most marked in that *C. typicus* has the antennæ more robust and with a tooth on the outer margin of the first, second, and fifth joints. The terminal spines of its swimming feet are more slender, and finely serrated, and each carrries two secondary spines, whereas the terminal spines of *C. hamatus* are coarse, the teeth set apart, and there is only one secondary spine.

In *C. typicus* the last thoracic segment is produced downwards on each side into a strong spine. On the first segment of the abdomen there are three plumose spines, and the tail setæ, which are five in number, are also plumose. In colour it is brown. It was tolerably plentiful.

Dactylopus tisboides is a small, graceful copepod, with an elongated body and a head produced into a short, conical rostrum. The antennæ are nine-jointed and taper gradually off from base to apex. In the male the rigid antennæ are hinged between the sixth and seventh joints. The fifth pair of feet are very small and consist of two flattened pieces of a somewhat triangular shape, with strong marginal setæ. In the female the antennæ are more densely setose than those of the male, and of course want the swellings consequent upon the hinge in the male organ. The fifth pair of feet consist of two broad ovate plates with long setæ on their outer margins; like the corresponding feet in the male they are small and insignificant. The feet generally are densely setose and spinous, and having the inner branches longer than the outer. The abdomen and caudal segments are short but well proportioned, and the tail setæ are very long. This copepod is found widely distributed, living both on the surface and at considerable depths; a variety also lives in the brackish water near mouths of rivers, etc. In colour it is of a rich brown.

Centropages hamatus (Lilljeborg). In many respects it is similar to the preceding copepod, but is still more like *C. typicus.* The body is slender and elongated, with the anterior antennæ twenty-three-jointed, the right male antenna is hinged between the eighteenth and nineteenth joints. There are strong-pointed teeth on the outer margins of the first, second, and fifth joints.

In the male the fifth pair of feet are adapted for swimming like the others, but the outer branch of the right limb has the last two joints developed into a grasping organ.

In the female the fifth pair of feet are similar to the others.

The spines of the swimming feet are long and straight, the teeth being much coarser and set further apart than they are in *C. typicus*, by which arrangement these two forms are perhaps most readily distinguished. This form was tolerably plentiful.

Parapontella brevicornis (Lubbock).—The rostrum is forked and the head separate from the thorax. Anterior antennæ eighteen-jointed, each joint having a few short hairs, and the first, eleventh, thirteenth, and sixteenth have long setæ. The right male antenna is peculiar; it has

only twelve joints, the last three being very long and slender. There is a hinge, the joints below which are considerably smaller, and a denticulated plate is present both above and below the hinge; there are hardly any setæ except on the terminal joint. The fifth pair of feet in the male are three-jointed, the right foot having two branches, the left only one. In the female the fifth pair of feet are two-branched, the branches being straight and single-jointed. The abdomen of the female is peculiar; there are three segments; the first is the longest, and is broad and strong; the second, when seen from the side, has a process projecting backwards over the dorsal surface of the third segment. When seen from above, in addition to this process, a small one is visible on either side; the third segment splits slightly into two, so as to receive the caudal segments, which are short, and bear setæ scarcely as long as the abdomen. The male abdomen has four segments, the last two bearing each a short sharp spine. This is a small and not over abundant copepod, of a brown colour.

Anomalocera Patersonii (Templeton).—The male is easily recognised by its club-shaped antennæ; its colour varies from a yellow or bright-red to a blue or light-grey, but all these colours may be present in the same animal. The body is elongated and large, and the anterior antennæ are twenty-four-jointed.

In the male the right antenna has a larger swelling than the left, the thirteenth, fourteenth, fifteenth, and sixteenth joints are included in it; the fourteenth joint carries a strong straight spine, hooked at the apex, and jointed at the base in a similar manner to the sting of a nettle; this spine has probably some function in connection with the swelling to which it is attached, it may be auditary as suggested by Brady, or it may serve as a weapon of offence. The fifth foot is one-branched, and four-jointed, the last two joints forming a strong grasping hand. The last thoracic segment is produced only in the right side into a projecting spine. In the female the antennæ are slender and have no swellings. The fifth pair of feet are two-branched, the inner of which is small and stunted, but the outer are long and two jointed. The abdomen consists of three segments, the first of which bears a spine produced backwards on the ventral surface, about half the length of the second segment. The rostrum is large and bifid, with, at its base, a pair of lateral eyes on each side, but there is also a median eye, which is stalked and situated immediately above the bases of the antennæ. This copepod was fairly abundant.

Cyclopidæ.

Oithona spinifrons (Boeck).—The anterior antennæ are ten-jointed, and form a very distinctive feature of this species on account of their extremely long setæ. All the ordinary swimming feet appear to be very much alike; both branches are three-jointed, and strongly setose on their inner margins. The fifth pair of feet, however, in the female are peculiar, each is composed of an exceedingly small basal joint, with two long setæ attached to it. The abdomen is very long and composed of five segments; the tail segments are short, with five apical setæ, and a small seta at the base of the tail segments. It is an exceedingly small translucent copepod, and exclusively a surface form. Only a very few specimens were obtained late in the season.

Harpaclicidæ.

Amymone Sphærica (Claus).—This copepod was not more numerous than the last. The first segment of the body is produced ventrally and

slightly posteriorly into a large somewhat triangular process. The last segment of the thorax and first of the abdomen coalesce, and form in the female a doubly-hooked projection, in the male a long triangular process reaching nearly to the similar projection from the thorax. Anterior antennæ in the female eight-jointed, in the male also eight-jointed, but hinged between the sixth and seventh joints. In both sexes the outer margin is set with setæ.

Posterior antennæ three-jointed, the first joint having at its apex a small secondary joint bearing setæ, the third joint has at its apex three or four long stout setæ.

Second foot-jaw very long and strong, forming a prehensile limb. The four pairs of swimming-feet are nearly equal in length and well provided with setæ, some of which are plumose. The fifth pair in the female two-jointed, the joints nearly equal in length and bearing a few setæ; fifth pair in the male one-jointed, long, and curved, bearing two long setæ at the apex and one on the outer margin.

Laophonte horrida (Norman).—Body elongated as before; head separated from thorax; rostrum long and sharp. On the median line of the back the cephalic segment is produced into one large spine, in the same position, each thoracic and the first two abdominal segments have *two* spines, and in addition, the first two abdominal segments have a pair of lateral spines, which are marginally ciliated. The posterior margins of all these segments are denticulated. The apex of each caudal segment bears two setæ, one very long and stout; on the outer margin of each segment are three shorter setæ. First pair of feet very long, and bearing a slender two-jointed peduncle. It was found in February and March but not in any abundance.

Laophonte similis (Claus).—Here the body is more slender than in the last, and it may be distinguished from others of the same genus by the fact that when seen laterally the dorsal aspect presents one uniform line, and is not broken up into a number of ridges by the body segments as in the other species; and also that the inner caudal setæ are as long as the entire animal.

The anterior antennæ are eight-jointed, those of the male being clawed at the apex, and with the fourth joint in the shape of a rough pear-shaped swelling. The fifth pair of feet in the female has a large basal joint, bearing internally four strong setæ, the second joint has fine setæ, and the margins of both are densely ciliated. In the male, the fifth foot is exceedingly small.

The first abdominal segment has a pair of setose appendages resembling a rudimentary foot. It is an exceedingly minute specimen ($\frac{1}{30}$th of an inch, ·85 mm. Brady). Several specimens were taken in from three to six fathoms water in March of this year.

Laophonte lamellifera (Claus).—The genus Laophonte includes a number of copepods with singularly long attenuated bodies, each segment being well marked in an annular fashion, giving the animal an appearance not unlike that of a caterpillar. *L. lamellifera* has the margins of all its segments, except the last, denticulated. The caudal segments are somewhat conical and longer than the last abdominal segments; there are two short setæ at the apex of each segment. Anterior antennæ five-jointed. It was taken in March in from three to four fathoms water, but was not common.

Thalestris mysis (Claus).—Body elongated, abdomen particularly slender; rostrum stout and sharp. Anterior antennæ nine-jointed. First pair of feet long, with both branches of equal length, outer branch terminating in four distinct claws. Fifth pair of feet in the female expanded into

large oval plates projecting downwards below the abdomen and forming a prominent feature. In the male the fifth pair are arranged more after the style of the corresponding limbs in *T. Clausii*, although differing in the arrangement of the setæ. Caudal segments as long as the last abdominal; inner setæ nearly the length of the entire animal, outer about half that length. This species was not found in any abundance, a few were taken in March, at a depth of from 3 to 6 fathoms.

Thalestris Clausii (Norman).—This stout little copepod was always got when the surface of the water was more or less covered with weed, and it also inhabits tidal pools.

The anterior antennæ are nine-jointed, the third and fourth joints in the male being constricted and the fifth very much swollen. The female antennæ are very thick at the base, but gradually taper off towards the apex. In the male each fifth foot has its outer branch much larger than its inner, and the outer has six setæ, the inner only three. In the female the fifth pair of feet are short, and the branches nearly of the same length; the outer with six setæ at its apex, the inner with five on the outer half of its inner margin.

The abdomen, like everything else belonging to this copepod, is stout and strong, being composed of five broad segments. The caudal segments are short, and the setæ on them are of different lengths, the inner one being as long as the abdomen, the outer only about half as long. In the female they are swollen at their bases.

Thalestris longimana (Claus).—This species was taken much more frequently than the former. The cephalothorax is broad and much arched dorsally, and the abdomen is much more robust than in *T. mysis.* Anterior antennæ nine-jointed. Posterior foot-jaw is exceedingly large and broad, having its inner margin strongly serrated, and at the apex a strong claw, altogether making a prominent powerful grasping organ. First pair of feet are long and slender, each branch having one long terminal claw. Fifth feet in the female are again broadened into large plates, the outer distinctly oval, but the inner somewhat more rectangular, both are ciliated; in the male they are very strong and bear a number of stout setæ. Outer tail setæ long and slender, inner fully the length of the animal.

Westwoodii nobilis (Baird).—Anterior antennæ short, those of the male six-jointed, of the female seven-jointed, all the joints are setiferous. The second foot-jaw has a long slender terminal claw. In the first pair of feet the outer branch is one-jointed, large, and ovate; the inner branch three-jointed, with a long and slender terminal claw something like that of the second foot-jaw, but not so much curved. There is no great difference between the fifth pair of feet in the male and in the female, except that in the former they are somewhat stouter. Caudal segments are short, each one bearing four setæ, the longest inside, fully the length of the abdomen. This copepod occurred pretty frequently in March of this year.

Harpacticus chelifer (Müller).—This is a small copepod with an elongated slender body. In the male the anterior antenna is hinged between the fourth and fifth joints, the first two joints forming a large jagged swelling terminating in a bent process, sparingly covered with setæ except at the base of the swelling. Fifth pair of feet composed of two flattened plates, one projecting from the inner side of the other, and strongly spinous. In the female the anterior antennæ are longer and more slender, nine-jointed, and bearing numerous long setæ. Fifth pair of feet have their inner joints somewhat triangular, while their outer joints are ovate; the setæ are strong and plumose. The caudal segments are exceedingly short, but the tail setæ very long. This species is like *H. flexus*

in the first pair of feet, and in the outer branch of the second foot in the male, but it may be distinguished from it by its nine-jointed antennæ (*H. flexus* only having eight joints), and in the form of the lower foot jaw, *H. flexus* is also much more sparingly covered with spines. It was pretty abundant about the end of September.

Zaus spinatus (Goodsir).—Body broadly oval; the lateral angles of the various segments produced posteriorly; margins of the first body segment beset with a few short setæ. Anterior antennæ nine-jointed and setiferous; posterior antennæ two-jointed, the first bearing a small two-jointed inner branch. In the female the outer branch of the fifth pair of feet, elongated, bearing five terminal setæ; inner branch short and broad, densely ciliated; in the male, the inner segment is wanting. Caudal segments short and broad, inner tail setæ about as long as the animal. It was found in March of this year, but not in any great numbers.

Peltidium depressum (Baird).—In the shape of its body it is very like *P. interruptum*, only of a larger size; the anterior antennæ also are similar. The fifth pair of feet are alike in both sexes; they have no spines on their sides, but have three at their apices, and at the apex of the first joint on the inner margin there is a long seta, and about the middle of the second joint, on the outer side, another but shorter one projects. The caudal segments bear five setæ, three of which are plumose, and one, the outer, strong and spinous. It is an easily identified species, as the large first segment and the abdomen are more or less translucent, allowing the antennæ and feet to be well seen, the second and third segments are, however, highly coloured with a crimson or purplish tint. Specimens of this species are sometimes found devoid of pigment altogether, and I found one of *P. interruptum* also in that condition. It was not common, although more plentiful than the preceding form.

Peltidium interruptum (Goodsir).—The body is elongated and depressed, the margin of each segment being clearly marked. Abdomen not distinct from cephalothorax, caudal segments and setæ short. Anterior antennæ nine-jointed; in the male knotted and clawed at the apex. Fifth pair of feet shaped somewhat like a seal's flipper, and strongly spinous, but with one slender marginal seta near the middle. In the female the anterior antennæ are much more slender than those of the male, although their second joints are somewhat swollen. The general colour is brown, but the margins of the body segments are red, or yellow, or they may be purple. This copepod was not common, the surface net only bringing up a few once or twice.

What appears to be a variety of this species was also met with. The foot of the fifth pair had only four setæ, two of which were apical, and two on the outer margins. The caudal segments bore only three setæ each, and the first abdominal segment had on its outer angles a strong spine, similar to the spine in the same position of *P. Crenulatum*.

Porcellidium fimbriatum (Claus).—It is tolerably easily recognised by the broad ovate appearence of its body, the fifth pair of feet forming two broad plates, with ciliated margins lying alongside of the two caudal segments; and of the caudal segments themselves which are broadened and ciliated very much in the same manner as the fifth pair of feet. It was common on Laminaria during October of last year.

Idya furcata (Baird).—Body elongated, gradually tapering from the cephalothorax towards the tail. Anterior antennæ eight-jointed, the fourth joint bearing a long curved olfactory organ. In the male, the median joints are much swollen and united. Posterior antennæ three-jointed, bearing several terminal setæ, five of which are hinged in the middle; the inner branch is long and four-jointed. The swimming feet are well

beset with spines and long plumose setæ. In the female the fifth pair of feet are two-jointed, the first joint being short, the second elongated, and bearing small cilia on the margin, and long setæ at the apex. It is much the same, but smaller in the male. The fourth and fifth abdominal segments, as well as the caudal segments, are exceedingly short; on the other hand, the inner tail setæ are about as long as the entire animal, the outer setæ are about half that length. This copepod was found in tolerable abundance in the months of February and March of this year.

Scutellidium fasciatum (Boeck).—Cephalothorax broad and ovate, segments of thorax produced backwards into strong pointed processes. Abdomen somewhat conical. Caudal segments very short, but inner setæ extremely long. Anterior antennæ nine-jointed, slender, and tapering, the male right antenna is hinged between the fifth and sixth joints. The swimming feet are densely covered with setæ and have also rows of long spine-like hairs. The fifth pair in the female are two-jointed, the first joint bearing at its distal end a seta on each side; the second having terminal setæ, and both being ciliated on the outer margin. In the male the fifth foot is similar but not so large, reaching only to the first abdominal segment, whereas that of the female reaches the last segment of the abdomen. This species was rather rare.

Artotrogidæ.

Cyclopicera nigripes (Brady and Robertson).—Cephalothorax broad; abdomen somewhat tapering, the first two segments produced laterally in sharp spines. Caudal segments are short and broad, the terminal setæ plumose. Anterior antennæ nineteen-jointed and tapering, the second last joint bearing an olfactory organ. First four pairs of feet short, both branches three-jointed; fifth pair two-jointed. The male has four caudal setæ, the female five, two are about the length of the abdomen, the rest are comparatively short. It was found in considerable numbers in the months of February and March.

Artotrogus magniceps (Brady).—The body is broad and ovate; the abdomen composed of four segments. The mouth is produced into a siphon. Anterior antennæ ten-jointed and slender, bearing scarcely any setæ except at the apex, where there is also an olfactory appendage. The anterior foot-jaw has a small claw near the apex. The swimming-feet have their first and second joints densely ciliated on the outer margin, and at each angle bear a number of lancet-shaped spines. The last joint has five plumose setæ on its inner margin, and a long serrated spine at its apex. Fifth pair of feet one-jointed, quadrate, bearing one long and two short apical setæ. Only some two or three specimens of this copepod were found in February and March.

APPENDIX F.—No. VIII.

ON A CRANGON, SOME SCHIZOPODA, AND CUMACEA NEW TO OR RARE IN THE BRITISH SEAS. By the Rev. Canon A. M. Norman, M.A., D.C.L., F.L.S.

The Scotch Fishery Board have sent me for examination some of the higher Crustacea which have been met with during the past year. Among these are many species of interest, and these are recorded in the following notes. With few exceptions the several forms are now first published as members of our Fauna, although some of them have been long known to myself. Mr Brook and Mr Scott must be congratulated on the success which has brought these species to light, and their discovery will, I trust, lead other naturalists to realise how much remains to be done among the great class of Crustacea in our seas; and that careful investigation will be amply rewarded even among the higher orders; but no real progress can be made with respect to the food of fishes until investigators are familiar with those smaller Crustacea which constitute so large a portion of that food. As an instance of this I may mention that Dr Baird, many years ago, published an interesting paper on the food of the vendace. No author at that time was more competent to undertake the task, and two of the Entomostraca in the stomachs were new to science, one of which, *Bosmina coregoni*, has not as yet been met with elsewhere in our islands than in Lochmaben. Yet when I repeated these investigations three years ago, I found that while the vendace fed on those species recorded by Dr Baird, a large portion, perhaps in bulk the largest portion, of its food, was *Leptodora hyalina*, an Entomostracan unknown to Dr Baird, and which, for its extraordinary tenuity, delicacy, and transparency, and its totally different form from that usual among Cladocera, was no doubt passed over by my old friend as something he could not make out, though it is much larger than the species he satisfactorily determined. A 'more dainty dish to set before a' fish cannot well be imagined than *Leptodora hyalina*, an animal so transparent that, notwithstanding its size, it can scarcely be detected in a glass of water unless held up against the light.

Order CARIDA.

Genus Crangon, Fabricius.

Crangon (*Cheraphilus*) *neglectus*, G. O. Sars.

Cheraphilus neglectus G. O. Sars, *Oversigt af Norges Crustaceer* (*Christ. Vidensk. Forhandl.*), 1882, p. 45, pl. i. fig. 7.

Rostrum *well rounded at the extremity*. Carapace with a single central spine, and a *second small tubercle-like spine on the central line behind it*, without the lobe-like folds of *fasciatus*, and the sulcus, which in that species defines their lateral regions much less distinct and deep. Antennal scale not greatly widened at the base. Last joints of maxilliped not broadly flattened. Second pereiopod longer, reaching one-third the length of the hand of first pair; its chela very weak, the finger and thumb parallel and touching each other, and apparently altogether too feeble to be used for grasping. Body not speckled with brown. Carapace more or less suffused with rufous or chestnut colour; a band across the fourth segment of pleon, and a second across the telson and uropods of the same colour.

'Ad oras meridionales et occidentales Norwegiæ in prof. 2–6 orgyarum

fundo arenoso' (G. O. Sars). Haakelsund, Kors Fiord, Norway, 3 fathoms (A. M. N.), Tarbert, Loch Fyne (Scotch Fishery Laboratory).

I took six specimens of this shrimp, ♂ and ♀, in 1878, in 3 fathoms water, at Haakelsund, Kors Fiord, West Norway, but at the time, from its general resemblance to *C. fasciatus*, passed it over as that species, as no doubt Norwegian naturalists had also done. In 1882 it was described by Professor G. O. Sars. Mr Scott has now added it to the British fauna, having forwarded to me for examination two or three small specimens which were taken at Tarbert. No other British specimens of this species are in my own collection, but it is not improbable that some of the northern specimens which have been referred to *C. fasciatus* belong to this new form. The two species to the unaided eye resemble each other closely, and one is apt to be led astray by the circumstance that, like *C. fasciatus*, *C. neglectus* commonly has the carapace dark coloured and a band of colour across the third segment of the pleon, and another across the telson and uropods, but the colour of these bands is chestnut ('badia,' Sars) in *neglectus*, but deep umber-brown in *fasciatus*.

Crangon fasciatus, Risso.

Crangon fasciatus Risso, *Crust de Nice*, p. 82, pl. iii. fig. 5, and *Hist. Nat. l'Eur. Mérid.*, v. p. 64 ; Milne-Edwards, *Hist. des Crust.*, ii. p. 342 ; Bell, *Brit. Crust.*, p. 259 ; White, *Pop. Hist. Brit. Crust.*, p. 107 ; Lucas, *Hist. Nat. Anim. Artic. Alger.*, p. 38 ; Heller, *Crust. des Südlichen Europa*, p. 228, pl. vii. fig. 10.

Ægeon fasciatus Kinahan, *Britannic Species of Crangon and Galathea*, p. 76, and woodcut.

Rostrum *broadly and abruptly truncate at the extremity*, its sides bending upwards, so that it is deeply sulcate in the centre. Carapace bearing a single central spine, on either side of which, and between it and the margin, are three slight lobe-like folds. Between this portion of the carapace and its hinder margin is a deeply cut sulcus arching forwards at the sides. Antennal scale short and very broad, unusually expanded on the inner side at the base. Maxillipeds, with the two terminal joints broad and flattened. Second pereiopods very short, just reaching the base of the hand of the first pair, the chela well developed (for a *Crangon*). Animals more or less speckled with dark brown, the carapace sometimes being entirely suffused with that colour. The epimera of the 2nd, 3rd, and 4th segments of pleon are generally marked with the same colour, and also two transverse bands, one on the fourth segment, the other across the telson and uropods.

Specimens of this species are in my collection from Jersey (Sinel & Co.), Guernsey and Falmouth (A. M. N.), Starcross, Devon (Mr C. Parker), Weymouth (Mr P. H. Gosse). I have also recorded it from Shetland, but cannot at this moment lay my hands on the specimens to re-examine them.

Other recorded localities are Salcombe Bay (Mr Alder), Dublin and Belfast (Dr Kinahan), Galway (Dr Melville), Mediterranean (various authorities).

Order SCHIZOPODA.

Family EUPHAUSIIDÆ.

Genus Boreophausia.

G. O. Sars *Preliminary Notice on the Schizopoda of H.M.S. 'Challenger' Expedition* (*Christ. Vidensk. Forhandl.*, 1883, No. 7), p. 12 ; *Report 'Challenger' Schizopoda* (vol. xiii.), 1885, p. 64.

Boreophausia Raschii (M. Sars).

Thysanopoda Raschii M. Sars, *Om Slægten Thysanopoda og dens Norske Arter* (*Christ. Vidensk. Forhandl.*, 1863), p. 14.

Euphausia Raschii G. O. Sars, *Oversigt af Norges Crustaceer* (*Christ. Vidensk. Forhandl.* 1882, No. 18), p. 51.

First found by M. Sars in the Christiania Fiord, and subsequently by his son, Professor G. O. Sars, on the West Coast of Norway.

It has lately been added to the British fauna. Dr Henderson has forwarded to me specimens for examination which were taken in the tow-net in the Firth of Forth by the Scottish Marine Station. I procured it in the same way in July last in Loch Fyne, when with Mr J. Murray on board the 'Medusa,' the vessel of the Scottish Marine Station, and subsequently to my leaving, it was again taken by the 'Medusa' between the islands of Bute and Cumbrae; and now (February 1886) Professor Ewart has found specimens in the stomachs of herrings caught on the East Coast, and examined by the Scotch Fishery Board.

Genus Nyctiphanes, M. Sars.

G. O. Sars, *Preliminary Notices Schizopoda, 'Challenger'* (*Christ. Vidensk. Forhandl.*, 1883), p. 23; *Report 'Challenger' Schizopoda* (vol. xiii., 1885), p. 114.

Nyctiphanes Norvegica (M. Sars).

Thysanopoda Norvegica M. Sars, *Forhandl. Scand. Naturf. i Christiania*, 1856, p. 169. *Om Slægten Thysanopoda* (*Christ. Vidensk. Forhandl.*, 1863), p. 2; G. O. Sars, *Oversigt af Norges Crustaceer* (*Christ. Vidensk. Forhandl.*, 1882), p. 50; *Norman, Last Report Dredging among the Shetland Isles* (*Brit. Assoc. Report*, 1868), p. 265.

Thysanopoda nana M. Sars, *Om Slægten Thysanopoda*, p. 15 (junior).

Thysanopoda Norvegica has been found throughout the entire length of the Norwegian coast from Christiania to Vadso (G. O. Sars); and I am indebted to Professor G. O. Sars for Norwegian specimens.

It has been known to me as a member of British fauna for twenty-five years, having been first found by myself at Shetland, and a few years afterwards sent to me about the same time by Mr David Robertson from the Firth of Clyde, and by Mr Thomas Edward from the Moray Firth.

The following are additional localities of specimens in my collection:—

1. Tow net, Valentia, Ireland, 1870. A.M.N.
2. Taken 7 miles off the Berling Islands, coast of Portugal, by Mr Davidson, July 22, 1870, when on board the 'Porcupine.'
3. 'Porcupine,' 1869; lat. 60° 34′ N., long. 4° 40′ W.
4. 'Triton,' August 1882, abundant in the Faroe Channel.
5. Eastport, N. E. America, from Professor S. I. Smith.
6. Observed in 1880 by me when on board the French exploring vessel 'Le Travailleur' in the Bay of Biscay.
7. During the summer of last year I procured it with the towing-net when with Mr Murray in the 'Medusa' in Loch Fyne. Subsequently other specimens were forwarded to me which had been taken in Loch Long (Clyde); these exceed in dimensions all others that I have seen, and measure 50 mm. long.
8. Lastly, Professor Ewart has sent me specimens taken from the stomachs of herrings on the East Coast of Scotland.

The species would thus seem to be universally distributed over the North Atlantic Ocean, though it was not met with by the 'Challenger' Expedition.

Nyctiphanes may be at once known from the other genera of the Euphausiidæ by the presence of a scale-like process on the basal joint of the antennules, which is projected upwards, and would seem to form a sort of screen for the eyes.

Tribe MYSIDEA.

Genus Erythrops, G. O. Sars.

Erythrops pygmæa G. O. Sars.

Nematopus elegans G. O. Sars, *Beretning om en i Sommeren* 1862 *foretagen Zoologisk Reise i Christianias ag Trondjems Stifter*, p. 42.

Nematopus pygmæa G. O. Sars, *Beretning om en i Sommeren* 1865 *foretagen Zoologisk Reise ved Kysterne af Christianias og Christiansands Stifter*, p. 17.

Erythrops pygmæa G. O. Sars, *Monographi over de ved Norges Kyster forekommende Mysider*, 1870, p. 33, pl. ii. figs. 20–28.

A very small species, about 6 mm. long, now added to the British fauna; the specimens procured by the Fishery Board Laboratory at Tarbert.

Genus Mysidopsis, G. O. Sars.

Mysidopsis gibbosa G. O. Sars.

Mysidopsis gibbosa G. O. Sars, *Beretning om en i Sommeren* 1863 *foretagen Zoologisk Reise*, p. 28; *Monographi over de ved Norges Kyster forekommende Mysider*, 1872, p. 23, pl. viii. figs. 1–3.

A single specimen taken by myself at Valentia, Ireland, in 1870. Three females sent for examination by the Fishery Board Laboratory which were procured on a Zostera bed at Tarbert, Loch Fyne, 1885. Now first recorded as British.

Mysidopsis angusta, G. O. Sars.

Mysidopsis angusta G. O. Sars, *Beretning om en i Sommeren*, 1863, *foretagen Zoologisk Reise i Christiania Stift*, 1864, p. 30; *Monographi over Norges Mysider*, 1872, p. 23, pl. viii. figs. 1–13.

A drawing of this species is before me, which was made from a specimen sent for examination by Mr T. Edward * from Banff in August 1863; a second British specimen has now (March 1886) been taken by the Fishery Board at Tarbert, Loch Fyne.

On the Norwegian coast it has been found in the Hardanger and Christiania Fjords, and at Aalesund.

Mysidopsis angusta has a very narrow, lanceolate antennal scale, which is ciliated all round, and is about twice the length of the peduncle of the

* This species is called in a catalogue of Crustacea at the end of Smiles' *Life of a Scotch Naturalist*, 'Mysis mixta.' It is much to be regretted that that list should have been published without revision.

antennules. The telson is cleft at the apex, and the sides of the cleft are quite plain, that is without any teeth or serration within the cleft, and by this character the species may be distinguished not only from the other species of *Mysidopsis*, but from all Mysidea which have as yet been described.

Genus Leptomysis, G. O. Sars.

Leptomysis lingvura, G. O. Sars.

Mysis lingvura G. O. Sars, *Beretning om en i Sommeren* 1865 *foretagen Zoologisk Reise*, p. 21; *Monographi over de ved Norges Kyster forekommende Mysider*, 1879, p. 35, pl. xi.

Although not hitherto recorded as occurring in our seas, *Leptomysis lingvura* was found by me twenty-six years ago in great abundance at Howden, County Durham, and shortly afterwards at Seaham Harbour. It remained with a MS. name in my collection until it was described by Professor G. O. Sars. In 1883 it was sent to me by Mr C. Parker from Starcross, Devon, and last year one or two specimens were forwarded to me for determination from Tarbert, Loch Fyne, by the Scotch Fishery Board. It would thus seem that the species is widely distributed round our coast.

Genus Mysis, Latreille.

Mysis inermis Rathke.

Mysis inermis Rathke, *Beytrage zur Fauna Norvegens*, p. 20; *Lilljeborg, Öfversigt af Vet. Akad. Handl.*, 1852, p. 3.

Mysis cornuta Kröyer, *Nat. Tidsskr.* 3 *die Række I.*, p. 26, pl. i. fig. 3, *a–g*; Goes, *Crust. Decap. Podoph. Marina Sueciæ*, p. 14.

Mysis truncatula G. O. Sars, *Beretning om en i Sommeren* 1863 *foretagen Zoologisk Reise*, p. 16 (monstrositas).

Mysis inermis Norman. *Last Report Dredging among the Shetland Isles* (*Rep. Brit. Assoc.*), 1868, p. 266. G. O. Sars, *Monographi over ved Norges Kysters forkommende Mysider*, 1879, p. 54, pl. xxvii.

Specimens of this species are in my collection from the following habitats:—Baltic Sea (Prof. Lovén), Bergen, Norway (Prof. Lilljeborg). Kors Fiord 1878, and Lervig Hardanger Fiord, Norway 1879; Shetland 1867, in rock pools; Guernsey 1865; Oban 1877; Cullercoats, Northumberland (A. M. N.). Tarbert, Loch Fyne 1885 (Scotch Fishery Laboratory). It has been sent to me for examination from the Moray Firth by Mr T. Edward.

Mysis arenosa G. O. Sars.

Mysis arenosa G. O. Sars, *Nye Bidrag til kundskaben om Middelhavets Invertebratfauna*, I. *Middelhavets Mysider* 1876, p. 16, pls. v. and vi.

This small species, described from the Mediterranean, was added to the British fauna by Mr C. Parker, who found specimens in 1884 at Starcross Devon, which he forwarded to me; and specimens have now been taken at Tarbert Loch Fyne, by the Scotch Fishery Laboratory.

Mysis Lamornæ Couch.

Mysis Lamornæ R. Q. Couch, *The Zoologist*, 1856, p. 5286. Norman, *Ann. Nat. Hist.*, ser. 3, vol. vi., 1860, pl. viii., figs. 4–6. Goes, *Crustacea Decapoda Podophthalmia Sveciæ*, p. 15.

Mysis aurantia G. O. Sars, *Beretning om en i Sommeren* 1863 *foretagen Reise*, p. 20.

Mysis Lamornæ G. O. Sars, *Monographi over de ved Norges kysters forekommende Mysider*, 1879, p. 65, pl. xxx.

This species is known to me from the following localities, whence specimens are in my collection—Falmouth (A. M. N.), Banff (Mr T. Edward), Seaham, Co. Durham (Mr G. Hodge), Loch Goil (Mr D. Robertson), Tarbert, Loch Fyne (Scotch Fishery Laboratory).

Genus Siriella, Dana.

(= *Cynthia*, Thompson.)

The more tangible generic characters are as follows:—Antennal scale subrhomboidal, the external margin naked until it terminates in a spine, whence it slopes to meet the inner margin, and is similarly setose; the scale has a small terminal joint, generally furnished with five setæ. Pereiopods seven-jointed, the terminal joint or finger biarticulate and nail-formed, at the end of preceding joint a dense bunch of setæ, which are microscopically spined. Telson elongated, linguiform, entire at the apex, furnished with marginal and terminal spines, so arranged that smaller spines alternate with larger. Outer uropods two-jointed, first joint without setæ on external margin, but furnished with a series of spines, the three distal spines exceeding the others in size. Pleopods of female as in *Mysis*; of male well developed, consisting of two multiarticulate swimming branches, with a curious two-lobed appendage attached to the base of the inner branch, one of these lobes being more or less spirally coiled.

Siriella Clausii, G. O. Sars.

Siriella Clausii G. O. Sars, *Middelhavets Mysider*, 1876, p. 81, pls. xxix. to xxxi.

Rostrum acute, triangular, not reaching beyond middle of first joint of antennules. Antennules with only one seta on inner margin of last joint of peduncle. Antennal scale subrhomboidal, rather narrow, of nearly equal breadth throughout, not quite reaching the end of peduncle of antennules, its extremity extending considerably beyond the spine of external margin. Pereiopods slender, the finger very slender, its first joint longer in its lesser (that is, front) length than broad, second joint or nail very slender and delicate, only slightly bent. Telson terminating in three spinules of equal length and two setæ between the distal lateral spines; sides of telson having 3 to 4 spines at base, separated by an interval from those which follow, on the distal portion 3 to 5 smaller spines occupying the intervals between the larger spines. Uropods wider than in *crassipes*, the outer with 10 to 12 spines on exterior margin of first joint, second joint broader in proportion than in *crassipes*, half as long again as broad. Inner uropods with spines throughout entire length of inner margin to the otolith, but not so crowded towards the base as in *crassipes*, smaller spines alternating with the larger on upper portion, but the four or five most distal spines without smaller intermediates.

Tarbert, Loch Fyne, April 1886 (Scotch Fishery Board Laboratory).

Goletta, Cagliari, Syracuse, Messina, and Spezzia in the Mediterranean (G. O. Sars).

The distinguishing characters of *S. Clausii* are the single seta on inner margin of last joint of peduncle of antennules, the slender legs and claws, and three equal-sized spinules between the ultimate spines of the telson.

Siriella norvegica, G. O. Sars.

Siriella norvegica G. O. Sars, *Untersog. over Christianiafjordens Dybvandsfauna*, 1869, p. 30; *Monog. over de ved Norges kysters forekommende Mysider*, 1879, p. 24, pls. xvii. and xviii.

Very like the last in general characters, and in rostrum, antennal scale, pereiopods, &c., but it attains a larger size, 19 mm. as against 10 mm. The following are points of distinction:—Last joint of peduncle of antennules with three setæ on inner margin; antennal scales perhaps rather longer, reaching end of peduncle of antennules; and rather wider in the middle than towards extremity. General character of telson as in last species, but the extremity having a central small spinule, flanked on each side by a still more minute spinule and pair of setæ between the ultimate spines. Outer uropods with 17 to 25 spines on outer margin of first joint. Inner uropods with smaller spines alternating with larger throughout the inner margin, except between the last and penultimate spine.

Norway, Christiania Fjord and West Coast (G. O. Sars); Lervig, Hardanger Fjord (A. M. N.).

Siriella norvegica has not as yet been found on our coast, but may be expected to occur. Its characters are given here, as well as those of the next species, for comparison with their very close allies.

Siriella crassipes, G. O. Sars.

? *Cynthia Flemingii* H. Goodsir, *Bell British Stalk-Eyed Crustacea*. 1853, p. 379 (*mas.*).

Siriella crassipes G. O. Sars, *Middlehavets Mysider*, 1876, p. 89, pl. xxxii.

In general characters very near the two preceding species, but the whole form is somewhat more robust in proportion to size, and the legs are much stronger. The following will supply diagnostic characters.

Antennules with three setæ on inner margin of third joint of peduncle. Antennal scale less parallel sided than in *Clausii*, widening slightly about the middle, as in *norvegica*. Pereiopods stout and strongly built, the joints more flattened and wider in proportion to their length than in the two preceding species; finger with first joint not longer in lesser (front length) than broad, second joint or nail strong and well curved. Telson terminating in a small spinule flanked on each side by the usual setæ, and a more minute spinule between the ultimate pair of spines; 3 to 4 basal spines of lateral margin, as usual, separated by an interval from following spines; on hinder portion 2 to 6 smaller spines (varying in number according to size of specimen) in the intervals between the larger spines. Uropods narrow; outer with 9 to 12 spines on external margin of basal joints, terminal joint twice as long as broad. Inner uropods with smaller spines alternating with the larger on the upper half of inner margin, but eight or more distal spines without such smaller spines between them.

This species has been known to me as a member of our fauna for the last twenty-five years, at which time I found it at Cullercoats, Northumberland. Specimens are also in my collection from Banff (T. Edward); Starcross, Devon (C. Parker, 1883); Jersey (Sinel & Co., 1884).

It is recorded in *The Life of a Scotch Naturalist* under the name

Mysis aculeata, a MS. name by which I had called the female when first found.

Cynthia Flemingii, Goodsir, is a male of this genus, and most probably of this species, but it is impossible to identify it with any degree of certainty from the description given.

In the Mediterranean this species was found by Sars in company with *S. Clausii* at Goletta.

Siriella Brooki, Norman, n. sp.

Very like the three species which have just been described. The rostrum is shorter, and bent downwards at the extremity. The antennules have one seta on inner margin of last joint of peduncle. The pereiopods are intermediate in thickness between those of *Clausii* and *crassipes*, the finger strong, the first joint not longer in its lesser (front) length than its breadth, second joint or nail strong and well curved. Telson terminating in a small spinule, flanked on each side by the usual setæ and a very minute spinule between the ultimate spines. Uropods narrow, outer pair with ten to twelve spines on exterior margin of first joint, terminal joint twice as long as broad. Inner uropod with seven or more distal spines of interior margin without smaller intermediate spines, and even above these they only become decidedly smaller by degrees. Colour of specimens which had been a few days in spirit, white, the eyestalks and peduncles of antenna suffused with yellow, telson and uropods more or less stained with yellow or pink. Length from the end of antennal scale to extremity of uropod rather more than half an inch, or 14 mm. About a dozen specimens, including both sexes, examined.

Very near to *crassipes*, from which it differs in being more slender in general form, with less strong pereiopods, and a single seta only on inner margin of ultimate joint of peduncle of antennules.

Possibly it may prove to be a variety of *crassipes*, but more extended observation is necessary to clear up this point.

With regard to the number of setæ on inner side of last joint of peduncle of the antennules, I may mention that in some specimens of *S. crassipes* I have not been able to make out more than two, and in one specimen of *S. Brooki* the left antennule has a second seta, while the right bears as usual one.

S. Brooki has been found at Tarbert, Loch Fyne, by the Fishery Board, in company sometimes with *S. Clausii.* I have named the species after Mr G. Brook.

Siriella armata (M.-Edw.).

Cynthia armata, M.-Edw., *Hist. Nat. d. Crust.*, ii. p. 463 (*mas fide* G. O. Sars).

Mysis Griffithsiæ, Bell, *Hist. Brit. Crust.*, p. 342.

Mysis rostratus, Guérin, *Iconog. Crust.*, pl. xxiii. fig. 3 (probably).

Siriella armata, G. O. Sars, *Middelhavets Mysider*, 1876, p. 96, pl. xxxv.

Animal very long and slender. Rostrum of great size, the extremity very acute and reaching the end of the second joint of the peduncle of the antennules. Antennal scale long and narrow, not quite as long as peduncle of antennules. Pereiopods slender. Telson terminating usually in four equal sized spinules and two seta between the ultimate spines. Wide intervals between the larger spines of lateral margin, these intervals occupied by six to ten smaller crowded spines of nearly equal size.

Uropods very long and unusually narrow; outer bearing very numerous (twenty-five to thirty) spines on external margin, second joint about one third to one half longer than broad. Inner margin of inner uropods with numerous spines gradually increasing in length distally, and without admixture of smaller spines. Length, three quarters of an inch, or 20 mm. The branchial appendage (?) of the second and following pleopods in the male is completely coiled.

The greatly developed rostrum at once distinguishes this species from the other British representatives of the genus; but another form from the Mediterranean, *Siriella frontalis*, M.-Edw.,* bears a close general resemblance, but the branchial appendages of the pleopods of male are wholly different, and not coiled, and on this ground Claus has instituted a new genus—*Pseudosiriella*—for its reception. There are three spinules at the termination of the telson in this species, and as many as fifteen smaller spines are in the intervals between the larger spines on the sides of the telson.

I have examined specimens of this species from Firth of Clyde, 1865 (D. Robertson), Starcross, Devon, 1884 (C. Parker), Jersey, 1884 (Sinel and Co.), Tarbert, Loch Fyne, 1885 (Scotch Fishery Laboratory), and unmistakable drawings have been sent to me of specimens taken at Plymouth (Spence Bate), and Castleton, Isle of Man (G. S. Brady). It has been recorded from Torquay (Griffiths), and Weymouth (Wm. Thompson). Milne-Edwards's type was from 'Noimoutiers,' and Sars took it in the Gulf of Goletta.

Order CUMACEA.

Genus Lamprops, G. O. Sars.

Lamprops fasciata, G. O. Sars.

Lamprops fasciata G. O. Sars, *Om en i Sommeren* 1862 *foretagen Zoologisk Reise i Christianias og Trondhjems Stifter*, 1863, p. 44; *Om den aberrante krebsdyrgruppe Cumacea* (*Vid. Selskab. Forhandl.*, 1864), p. 66.

First sent to me as British by Mr David Robertson, who found it at Helensburgh in the Firth of Clyde, and was (March 1886) taken by the Fishery Board Laboratory among sand at low water, Tarbert, Loch Fyne.

'Habitat rara in sinu Nidrosiensi prope urbem Stenkjær in prof. 12–20 orgyarum, adque insulas Lofotenses, ubi unicum inveni exemplar' (G. O. Sars).

It may at once be known from the other described species of the genus by three oblique folds which are present down the sides of the carapace.

The above is the only species of the genus as yet known in the British sea. Other closely allied forms which were included in this genus have recently been separated by Sars, under the name *Hemilamprops*. Of this restricted genus we have in Britain the following representatives. *Hemilamprops* is a MS. genus of G. O. Sars, which he has not yet defined.

* *Pseudosiriella frontalis*, M.-Edw., is also a member of the British fauna. I have a drawing made many years ago, at a time when I had no other Crustacea than British, which undoubtedly represents the ♀ of this species, but unfortunately no locality is under the drawing. The specimen was probably one sent to me for examination.

Hemilamprops rosea (Norman).

Vaunthompsonia rosea, Norman, *Trans. Tyneside Nat. Field Club*, v. (1862), p. 271, pl. xiii. figs. 1–3. ♀

Cyrianassa elegans, Norman, *loc. cit.* p. 275, pl. xiv. figs. 1–6. ♂

Lamprops rosea, G. O. Sars, *Om den aberrante krebsdyrgruppe Cumacea* (*Vid. Selskab. Forhandl.*, 1864), p. 64.

Hemilamprops rosea, G. O. Sars, *Oversigt af Norges Crustaceer* (*Christ. Videnskabs. Forhandl.*, 1882), p. 11.

Fifty to one hundred miles east of Tynemouth, Northumberland (A. M. N.); Lough Foyle, Ireland, 15 fathoms ('Porcupine' Expedition).

In Norway I have dredged it at Drobak in the Christiania Fjord, and off Lervig in the Hardanger Fjord, also at Floro. Sars has found it as far north as the Lofoten Islands.

Hemilamprops cristata, G. O. Sars.

Lamprops cristata, G. O. Sars, *Nye Dybvandscrustaceer fra Lofoten* (*Vid. Selsk. Forhandl.*, 1869), p. 13.

Lamprops cristata, Norman, *Crustacea Cumacea of the 'Lightning,' 'Porcupine,' and 'Valorous' Expeditions, Ann. Nat. Hist.*, ser. 5, vol. iii. 1879, p. 68.

Hemilamprops cristata, G. O. Sars, *Oversigt af Norges Crustaceer* (*Christ. Videnskab. Forhandl.*, 1862), p. 11.

Firth of Clyde, 1860 (Mr D. Robertson); south of Rockall, lat. 56° 7′ N., long. 14° 19′ W., 630 fathoms ('Porcupine,' 1869).

On the Norwegian coast I have taken it in 150 to 180 fathoms, off Midtö Lighthouse, and in Stoksund 80 to 100 fathoms, both in the Hardanger Fjord.

Sars has also dredged it in the Hardanger Fjord off the Island of Husö, 100 to 105 fathoms, and at Lofoten in 120 to 200 fathoms.

There are six European species belonging to these two genera. The genera are distinguished from all other Cumacea by having a well-developed, long, flattened, linguiform telson, which is broad at the extremity, and terminates in several spines; the carapace is small, the three first pair of feet have fully developed natatory palps, and the two following pair two-jointed rudimentary palps. In the male the antennules have a bunch of cilia at the extremity of the peduncle, and the pleon is furnished with three pairs of natatory feet.

The following more salient features will enable the species to be separated. It is probable that more of these forms await discovery in our own seas.

Lamprops fasciata, G. O. Sars. Carapace with three well-developed oblique folds on the sides. Telson with one or two pairs of lateral spines, and terminating in five spines—Britain, Norway.

Lamprops fuscata, G. O. Sars. Carapace smooth, rostrum acutely produced. Telson with one or two pairs of lateral spines, terminating in five spines—Norway.

Hemilamprops rosea (Norman). Carapace smooth, rostrum not produced, the front forming nearly a right angle. Eyes well developed. Telson not much contracted towards the extremity, with one or two pairs of lateral spines, and terminating on seven or eight spines. Animal more or less stained with a rich rose colour—Britain, Norway.

Hemilamprops assimilis, G. O. Sars. Carapace and rostrum nearly as in the last; eyes rudimentary. Telson suddenly contracted near the

extremity, with one pair of lateral spines, and terminating in six spines. Integuments very delicate. Animal without colour—Finmark.

Hemilamprops uniplicata, G. O. Sars, Carapace with one oblique fold on the sides. Telson with four or five pairs of lateral spines, and terminating in three spines—Norway.

Hemilamprops cristata, G. O. Sars. Carapace having the anterior half of the dorsal line denticulately serrated. Telson with two or three pair of lateral spines, and terminating in three spines—Britain, Norway.

The males in all cases have the carapace smooth, and therefore present greater difficulties in determination than the females, to which the above characters, as regards the carapace, refer. To determine the males it will be necessary to refer to the full description given by Sars of the species.

Genus Diastylis, Say.

Diastylis rugosa, G. O. Sars.

Diastylis rugosa, G. O. Sars, '*Om den aberrante Krebsdyrgruppe Cumacea og dens nordiske Arter*' (*Vid. Selskab. Forhandl.*, 1864), p. 41. *Nye Bidrag til kundskaben om Middelhavets Invertebratfauna* ii., *Middelhavets Cumaceer*, 1879, p. 98, pls. xxxiv. to xxxviii.

Diastylis strigata, Norman; *Cumacea of the* '*Lightning*,' '*Porcupine*,' *and* '*Valorous*' *Expeditions*, *Ann. Nat. Hist.*, ser. 5, vol. iii. p. 62 (*mas adultus*).

The Fishery Board has found specimens of the species at Tarbert, Loch Fyne.

Its known distribution is Christiania Fjord, 10 to 12 fathoms; Christiansund; Utne, Hardanger Fjord, 30 to 50 fathoms (G. O. Sars); Denmark; West France; Syracuse, Messina, and Naples in Mediterranean (G. O. Sars).

Valentia harbour, Ireland, female, and off Valentia, tow-net, 1870 (A. M. N.); Lough Swilly, County Donegal, in 15 fathoms ('Porcupine' Exped., 1869); Drobak Christiania Fjord, 1879, and Lervig Hardanger Fjord, 1878, Norway (A. M. N.).

Genus Pseudocuma, G. O. Sars.

Pseudocuma cercaria (Van Beneden).

Leucon cercaria, Van Beneden, *Recherches sur la Faune littorale de Belgique, Crustacés*, 1860, p. 85, pl. xiv.

Pseudocuma bistriata, G. O. Sars, '*Om den aberrante Krebsdyrgruppe Cumaceer*' (*Vid. Selskab. Forhandl.*, 1864), p. 70.

? *Cyrianassa longicornis*, Spence Bate, *Nat. Hist. Review*, vol. v., 1858, p. 203.

Cuma bella, Meinert, *Crust. Isop. Amphip. et Decapoda Daniæ* (*Naturhist. Tidssk.* 3 R. 11 B., 1877), p. 179.

Cuma cercaria, Van Ben., Meinert, *Crust. Isop. Amphip. et Decapoda Daniæ* (*Naturhist. Tidssk.* 3 R. 12 B., 1880), p. 497.

Pseudocuma cercaria, G. O. Sars, *Middelhavets Cumaceer*, 1879, p. 114, pl. xl. to xlii.

This small species seems to be the most numerically abundant of the Cumacea in the British seas. Its distribution is as follows :—

Belgium (Van Beneden); Denmark (Meinert); Norway, from Christiania to the Lofoten Islands (G. O. Sars); Mediterranean, at Goletta, Messina, and Syracuse (G. O. Sars).

I can myself testify to the following localities:—Whitby, Yorkshire, and Seaton Carew, County Durham (A. M. N.); Sunderland (G. S. Brady); Cumbrae, Firth of Clyde (D. Robertson); Tarbert, Loch Fyne (Fishery Board Laboratory); Naples (Zool. Stat.).

It is a shallow-water form, found on a sandy bottom, usually in 0–10 fathoms. Now first recorded as British.

APPENDIX F.—No. IX.

On RED and PALE MUSCLES in FISHES. By William Stirling, M.D., Sc.D., Brackenbury Professor of Physiology and Histology in Owens College, and Victoria University, Manchester, formerly Professor of the Institutes of Medicine (Physiology) in the University of Aberdeen. With 3 Plates (III., IV., V.)

For a long time anatomists and physiologists have been acquainted with the fact that the muscles of different animals differ notably in colour, structure, and physiological properties, and that even in the same animal there are differences in the colour amongst the muscles. Every one is familiar with the fact that the muscles of the breast of a fowl are lighter in colour than those of the legs; and even after being cooked this difference is quite marked. The muscles of the breast in some birds also differ in colour; thus in the partridge the pectoralis major is dark coloured, while the minor is much lighter in tint. Similar differences obtain in the rabbit, as was shown by W. Krause* in 1868. Thus the semitendinosus is a *red* muscle, while the vastus internus and adductor magnus are *pale* muscles. That the colour of the red muscles is not due to the blood present in their blood vessels was proved by W. Kühne,† who washed out the blood by means of a half per cent. solution of common salt, and found that the muscles still retained their colour—that, in fact, it was incorporated with the *sarcous* substance, and was identical with hæmoglobin, giving a spectrum the same as that of the blood pigment. Ranvier‡ observed that the red and pale muscles of the rabbit differed not only in colour but also in histological and physiological properties. *Structurally* the fibres of the *red* muscles, as compared with the pale, are smaller in diameter, while the round muscle-corpuscles or nuclei are numerous, and placed peripherally under the sarcolemma; in the pale muscles, however, they are fusiform, fewer, and scattered throughout the sarcous substance. In the pale muscles the transverse striation is less regular than in the red. They also differ in the arrangement of their blood-vessels. In the pale muscles the arrangement of the muscular capillaries is such as obtains in ordinary striated voluntary muscles. In the red muscles, however, the capillaries between the muscular fibres are more wavy, while the transverse connecting capillaries and the veins frequently have small oval or fusiform dilatations on them like little aneurisms. Physiological they differ also. Ranvier showed that the pale muscles were not so easily tetanised as the red ones; but he estimated the number of shocks neces-

* *Die Anatomie d. Kaninchens.* 1868.

† Ueber d. Farbstoff d. Muskeln. *Virch. Arch.* 1865.

‡ *Archives de Physiol. Norm.*, &c. 1874, p. 5.

sary to produce tetanus at far too high a number. Kronecker and Stirling, in their investigations on the "Genesis of Tetanus,"* showed that in this Ranvier was in error, as they found that 10 stimuli per second cause a tolerably complete tetanus of the red muscles, while the pale muscles of the rabbit require 20–30 stimuli per second to produce complete tetanus. The duration of the contraction of the red muscles further is nearly twice as long as that of the pale. The red muscles, therefore, contract more slowly, and their contraction is more sustained and prolonged. They thus form a less highly evolved form of muscular tissue—*i.e.*, speaking physiologically as regards mere rapidity of contraction.

Meyer has described similar *differences* in the colour and general structure of the muscles of the *guinea pig.*†

A similar distinction exists also in the muscles of *insects*, as shown by R. V. Limbeck.‡ Thus in the common water beetle, *Dysticus marginalis*, even with the unaided eye, on opening the abdomen and thorax, one sees a sharp contrast in the colour of the muscles exposed to view. While the muscles in the abdomen are pale, the muscles which almost fill the thorax have a yellowish, indeed almost a brownish colour, and are thus sharply marked off from the others. They differ markedly in structure.

FISHES.—Gunther says, as regards *fishes*, that 'Each lateral muscle is 'divided by a median lodgitudinal groove into a dorsal and ventral half; 'the depression in its middle is filled by an embryonal muscular sub- 'stance, which contains a large quantity of fat and blood-vessels, and 'therefore differs from ordinary muscle by its softer consistency, and by 'its colour, which is reddish or grayish.'§

Arrangement of Muscles.—The muscles of an osseous fish are arranged into vertical segments or *myotomes* corresponding in number with the vertebræ, and separated from one another by flat septa of connective tissue, while the fibres run in a fore and aft or horizontal course from one septum to the next one. They are therefore very short, and the connective tissue is peculiar in this respect, that boiling for a few minutes suffices to dissolve it, so that the muscular myotomes are easily separated one from another. The myotomes are connected internally with the bones of the vertebral column, and externally with the skin. The myotomes do not run in the same vertical plane, but pursue a zig-zag course. From the dorsal middle line they incline backwards then forwards, then backwards, and then bend at an angle forwards to reach the middle line (Plate IV. fig. 1), so that the apices of the parts above the middle line look backwards, and those at it look forwards, while below this line another series of apices are directed towards the tail. One set is described as a dorsal longitudinal muscle with tendinous insertions‖ and the other as a ventral longitudinal muscle.

Colour of the Muscles.—I daresay every one is more or less familiar with the fact that, when a *herring* is boiled and the skin stripped off, a thin layer of a reddish-brown tint is seen chiefly along the sides, and shading off dorsally and ventrally under this is the paler muscle. In the unboiled or fresh condition there is also a sharp difference in colour between these two muscles, the darker one corresponds to the red muscles of rabbits, and the deeper and far bulkier myotomes of lighter tint to the

* *Journal of Physiol.* i., p. 384.

† Uber rothe u. blase quergest. Muskeln, *Archiv f. Physiol.* von du Bois Reymond, p. 217. 1875.

‡ Zur Kenntniss d. Baues d. Insectenmuskeln. *Sitzb. d. k. Akad. d. Wissensch. Math. Nat. Clas.* Bd. xci. 1885.

§ *Introduction to the Study of Fishes*, p. 93.

‖ Owen, *Comp. Anat. and Phys. of Vertebrates*, i. p. 204.

pale white muscles. The red fibres are arranged in series with the myotomes. The red muscle is thickest along the lateral line, although it does not follow this line exactly, and it shades off dorsally and ventrally. The appearance of these red fibres is shown in Plate IV., fig. 1, in a herring after being boiled. The exact distribution and thickness of this muscle is better seen in a transverse section through the body, as is shown in Plate V., fig. 1 R, being in front of the dorsal fin and behind the anal fin. It will be observed to be crescentic in shape and thickest in the interval between the dorsal and ventral portions of the myotomes, and tapering away to become thinner as it passes dorsally and ventrally. The tint of it is fairly well represented in the figure. A thin slip from it passes inwards horizontally at each myotome, to be attached to the vertebral column. As shown in Plate V., fig. 5, two thin red muscles diverge from the middle line just at the base of the tail, to be inserted into the fin rays.

Whiting.—A similar arrangement of a segmented lamina of a coloured or red muscle exists in the whiting, as shown in Plate IV., fig. 2, but when boiled the colour passes more into the yellow. It does not form, however, quite so continuous a layer as in the mackerel, being thickest over the centre of each myotome and thinner opposite the connective tissue septa. In transverse section its distribution is shown in Plate V., figs. 3, 4. In these figures it is thickest just under the position of the lateral line and between the dorsal and ventral parts of the myotomes, being wedge-shaped in section (R). From this wedge-shaped part, as seen in section, fibres directed longitudinally pass down to the vertebral column. Two other thin wedge-shaped parts exist in the intervals between adjoining cones of the myotomes, one above, R′ and one below, R′ on each side, and some prolongations of these pass inwards to reach the middle line. Some coloured fibres exist in connection with the dorsal fins.

Mackerel.—A similar red muscle exists in the mackerel, where, however, it is deeper tinted and more highly developed, as is shown in Plate V., fig. 9. In fig. 10 its crescenting shape and continuation inwards on both sides as a well-marked horizontal prolongation of muscular substance attached to the vertebral column. The red muscle is so strongly marked that it at once arrests the attention when a transverse section of the body of the animal is made.

Haddock.—An arrangement similar to that in the haddock exists in this fish, the lighter yellow of the boiled red muscle being shown in Plate IV., fig. 6. There is the corresponding radiating muscle attached to the rays of the tail.

Similar red muscles exist in many fishes, *e.g.*, the salmon, and many others; and as soon as time and opportunity occur it is my intention to investigate further the distribution and arrangement of these red muscles in fishes generally.

In flat fish, such as the *plaice*, the red muscle is well developed, as shown in Plate III., where the light brown tint of these muscles after boiling is shown. The fishes were all boiled to enable the skin to be readily removed. It will be seen to follow the zig-zag course of the myotomes, being thickest along the mesial lateral line, and thinner as it goes outwards; while it is thickest over the centre of each myotome, and thinner over the septa of connective tissue. A thin separate red muscle, blended with or rather lying in a depression of a white one, is to be seen along the marginal fin rays. The latter appear most distinctly when the fish is skinned and left exposed to the air for a time, when the pigment, even though altered by boiling, assumes a deeper tint. In other flat fish, such as the flounder, a similar red muscle exists.

Histological Structure.—On making a transverse section of a whiting or haddock across the mesial lateral line, so as to include the red muscle at its thickest part, and also the pale muscles, a low-power view reveals the appearance seen in Plate V., fig. 11, where F is the subcutaneous fascia investing the muscle, and sending a well-marked septum S to the vertebral column V C. Other concentric septa, S S S, separate the muscular fibres into lamellæ. It will be seen at once that there are two kinds of muscular fibres—one (the red) lying under the fascia, and continued as a thinner layer inwards to the vertebral column, and the other forming the great mass of the laminæ—the pale white muscles. On transverse section the red muscle (R) appears darker, and its sectional area is smaller than the pale fibres, which are thicker fibres altogether (P). In this respect they correspond to the red muscles of the rabbit. There is no difficulty in separating the groups of red fibres from the pale ones. All are supported by a certain amount of connective tissue—the septa playing the part of a perimysium, from which fibres proceed as a sustentacular endomysium.

The sharp distinction between these two kinds of muscle is far better marked in the mackerel. In a transverse section the red muscles are seen lying in a depression of the pale ones, and accurately mapped off from the latter by a septum. The red fibres are much smaller than the pale ones. Between the large pale fibres are many fat-cells, forming a nearly continuous network between the fibres, while this exists to a much less degree in the area of the red muscles. It is very probable that the condition of these fat-cells varies at different periods of the year.

If one of the red muscles of a whiting or mackerel be teased out so as to isolate a muscular fibre, on examining it with an ordinary power of the microscope, it is seen to be transversely striated, but the striæ may not be very marked, and nuclei are seen with difficulty. What is very remarkable, however, is the existence in the substance of the sarcous matter of rows of small, bright, refractive granules, in some fibres assuming a more or less longitudinal course, three, four, or more rows, being found abreast in a fibre. (Plate V., fig. 7.) In others the granules may be more densely packed, and assume a more transverse direction. All the red fibres are not equally granular—some being more so, others less. The small granules are undoubtedly *fatty* in their nature, for, apart altogether from their optical characters, they are soluble in ether, and are blackened by osmic acid. When ether is added they disappear, and the fibre assumes the appearance of a transversely striated fibre. A transverse section of such fibres is particularly instructive (Plate V., fig. 8), for we see the polygonal shape of the fibres, and note that the granules lie in the substance of the sarcous matter. It is no uncommon thing to meet with granules in the substance of muscle. In the muscles of some insects they are particularly well marked, but in these cases they are not fatty in their nature. They are spoken of as 'interstitial granules.' Flögel has described the existence of granules in the muscles of insects, and Biedermann* has shown that they occur in the fibrillæ of the thoracic muscles of the humble-bee. These granules differ both in their position in the sarcous substance and in their chemical nature, from those found in the red muscles of fishes. It has been shown that section of the vagi in the neck of a pigeon results in death of the animal, under conditions quite different from those that obtain in a mammal. Section of the vagi in the neck of a rabbit is followed by pneumonia and death within a limited period. In a bird—*e.g.*, pigeon—death also takes place, but there

* Zur Lehre v. Bau d. quergest. Muskelfaser, *Sitzb. d. K. Akad. d. Wiss. zu Wien*, lxxiv.

is no inflammation of the lungs; the heart, on the other hand, undergoes 'fatty degeneration,' not throughout its entire substance, but here and there foci are found where this fatty transformation has taken place.* Now, fatty degeneration is a very common retrogressive metabolic transformation, not only in the heart muscle, but in the muscles of the body generally. These fibres, composing the red muscles, present all the appearances of a muscle in a state of fatty infiltration or fatty degeneration.

As to the exact position of the fatty granules in relation to the elements of a muscular fibre, there is some doubt. Most probably they exist in the cement substance between the individual fibrillæ, and it is possible that they may stand in some relation to the nutrition of the fibre itself, so that, instead of being a metabolic product in the downward direction, they may have some relation to the constructive metabolism of the fibre itself. We know, from the researches of Arnold † and L. Gerlach, ‡ that the cement substance is the channel along which the sarcous substance seems to receive its nutriment. Sulpindigotate of soda is deposited in granules in what is regarded as the cement substance between the bundles of fibrillæ.

So far I have had no opportunity of ascertaining whether the arrangement of the blood-vessels differs in the two kinds of muscles, or whether there is any difference in their chemical composition, more especially as regards the amount of glycogen they contain. In mammals the red muscles contain more glycogen than the pale ones. These points are reserved for future research, and are not without interest, seeing that in the mammal so marked differences obtain in these respects. This communication is merely a preliminary statement of some of the results already obtained.

I have made some experiments on the *relative digestibility* of the white and red muscles, but these I reserve for a future communication.

I am indebted to my pupil, Mr Middleton, for the excellent drawings illustrating this paper.

DESCRIPTION OF THE PLATES.

Plate III.

Side view of a plaice boiled, and the skin removed, to show the distribution of the red or coloured muscles.

Plate IV.

Fig. 1.—Side view of the great lateral red muscle in a herring after being boiled and the skin removed.

Fig. 2.—Whiting similarly treated.

Plate V.

Fig. 1.—T.S. of the body of a herring, just in front of the dorsal fin, showing the red lateral muscle.

Fig. 2.—A similar section of a herring just behind the anal fin. R., red muscle; D., dorsal; V_2, ventral.

Fig. 3.—Transverse section of the body of a whiting. R, R′, R″, Red or coloured muscles.

* Knoll, Über Myocard. v. d. Folgen d. Vagussect. b. Tauben, *Zeit. f. Heilk.* i.
† Die Abscheidung d. indigosch. Natrons i. Muskelgeweb. *Virch. Arch.* 1877.
‡ Das Verhalten d. indig. Natrons i. Knorp. lebend. Thiere. Erlangen. 1876

Fig. 4.—Similar Section, showing relation of coloured muscle to the lateral line.
Fig. 5.—Tail of a herring showing red muscles.
Fig. 6.—Tail of a haddock showing red muscles.
Fig. 7.—Red muscular fibre of a whiting, showing the fatty granules in the sarcous substance.
Fig. 8.—Transverse section of red muscular fibres with fatty granules.
Figs. 9 & 10.—Transverse section of the body of a mackerel.
Fig. 11.—Transverse section of the body of a whiting. Low-power view. F., subcutaneous fascia; R., red muscles; P., pale muscles; S., septa; V.C., vertebral column.

APPENDIX F.—No. X.

ON THE BLOOD OF NEPHROPS NORWEGICUS. By W. D. Halliburton, M.D. (Lond.), B.Sc., M.R.C.P., Sharpey Physiological Scholar, and Fellow of University College, London.

The nephrops norwegicus is one of the commoner decapod crustaceans; it is often called the sea-crayfish; and it belongs to the same family of Decapoda, the Astacidæ, as do the common fresh-water crayfish (*Astacus fluviatilis*) and the lobster (*Homarus vulgaris*).

Large quantities of this animal were sent to me from Scotland by Professor Cossar Ewart for the purpose of determining the properties of their blood or hæmolymph. A certain proportion of the animals died in transit, but a sufficient number remained alive for the purposes of the investigation.

I have to thank Professor Schäfer for much help and valuable suggestions during the progress of the investigation.

The blood of the nephrops may be stated in general terms to have similar properties to those of other decapods, but it exhibits certain differences of degree, though not of kind, which will be dwelt upon presently.

It will be convenient to divide the account of the examination of this blood into the following parts:—

Part I. The Blood as a Whole.
Part II. The Phenomena of Spontaneous Coagulation.
Part III. The Proteids of the Plasma and Serum.
Part IV. The Colouring Matters of the Blood.
General Conclusions.

Part I.—The Blood as a Whole.

The blood is obtained by making acts in the ventral region in the soft integuments between the abdominal segments, or in the claw. In this way, from a large nephrops, some twenty or thirty cubic centimetres of blood can be readily obtained.

Colour.—When first shed the blood is nearly colourless. It has an opalescent or milky appearance from the presence of numerous amœboid corpuscles in it. This appearance is, however, but momentary, for coagulation begins to occur almost instantaneously. The blood, after being a few minutes in contact with the oxygen of the atmosphere, acquires an indigo-blue tinge. This colour, which is seen with great

readiness in the nephrops, is due to the oxygenation of a proteid body which exists in solution in the blood plasma. The name hæmocyanin was given to it by Fredericq. In the reduced state this body is colourless. The blue colour is often much obscured in the lobster and the crayfish by a red pigment called tetronerythrin ; also in solution in the blood plasma. This pigment is also present in the blood of the nephrops, but in such small quantities as not to obscure the blue colour due to oxyhæmocyanin.

Specific Gravity and Reaction.—The specific gravity of the blood varies between 1025 and 1030. Its reaction is always faintly alkaline.

Constituents.—The blood contains the following classes of bodies :—

(1.) *Proteids* or albuminous substances.

(2.) *Salts*, which resemble those of the water in which the animal lives, and are more abundant than in such an animal as the common crayfish, which lives in fresh water.

(3.) *Extractives.*—Among these are a small amount of tetronerythrin, a small amount of urea, and a varying quantity of certain fatty bodies which I have not further examined.

The following table exhibits the average percentage proportions of these constituents in the nephrops' blood, and in the blood of some other of the commoner decapods, with which I have compared it :—

	Nephrops.	Astacus.	Lobster.	Crab.
Water	89·06	95·14	93·49	89·92
Solids	10·94	4·86	6·51	10·08
Proteids	4·60	2·19	3·02	6.10
Other organic matters	3·57	1·54	·55	1·28
Salts	2·77	1·13	2·94	2·70

Part II.—The Phenomena of Spontaneous Coagulation.

Coagulation begins almost immediately the blood is shed, and the coagulum that forms presents the appearance of a network of white fibres throughout the liquid. This soon begins to contract, and squeezes out drops of a perfectly clear liquid ; in a few minutes more this liquid, as well as that between the fibres first formed, sets into a clear jelly. The second process, or jellying, is in reality only a continuation of the first or formation of the fibre-like clot. Both clots possess the same chemical properties. The second or jelly-like clot finally contracts and squeezes out serum.

The substance of coagulation resembles very closely the fibrin of vertebrate blood. Under the microscope it can be watched forming: at first only the cells, which have the ordinary amœboid characters described in the blood of other crustacea, are seen. Then they shoot out long processes which interlace with one another. This was what Mr Geddes (*Proc. Roy. Soc.*, vol. 20, 1879-80) described as a Plasucodium. There is, however, in addition, an intercellular substance of coagulation which is distinctly fibrinous in appearance. The fibres which form have not such a well-defined outline as the branches of the cells, and are therefore quite easily distinguishable from them. The chemical properties of this crustacean fibrin are also similar to those of vertebrate fibrin, with the exception that it is not so readily soluble in weak solutions of neutral salts, nor does it swell so markedly in weak hydrochloric acid.

The similarity of the chemical and microscopical properties of this body to fibrin naturally leads one to infer that it may be formed in a similar manner, namely, by the solidification of a previously-soluble proteid or fibrinogen, and this supposition turns out to be a true one. This is brought out by the consideration of the following seven points, which show the resemblance of the process of coagulation to that observed in vertebrate blood :—

1. It does not take place in the living vessels.
2. It takes place after the blood is shed.
3. It can be prevented by the admixture with the blood of certain large proportions of neutral salts. This is in contradiction to what previous investigators on the subject of crustacean blood have said (*Fredericq, Extrait des bulletins de l'Acad. Royale de Belgique,* tome xlvii., No. 4. 1879. *Krukenberg, Vergl. Phys. Studien,* 2*te Reihe,* 1*te Abth.*, s. 49. Heidelberg, 1882). They did not apparently use a sufficiently large amount of such salts. It is necessary to have at least four times as much saturated solution of magnesium sulphate, or ten times as much saturated solution of sodium chloricle, as of blood. Sodium sulphate does not prevent the coagulation : this is different to what obtains among vertebrata. Subsequent dilution of this salted blood with water brings about coagulation.
4. The formation of the fibrin is due to the solidification of a proteid body or fibrinogen, which exists in solution in the blood planera. This can be precipitated by saturating with magnesium sulphate or sodium chloride, washed and redissolved by water. The addition of fibrin ferments, prepared either from crustacean or from mammalian blood, to this solution brings about the formation of fibrin.
5. This conversion of fibrinogen into fibrin is brought about, as indicated in the last paragraph, by a ferment action.
6. The source of this ferment is the amœboid corpuscles of the blood. The ferment can be prepared from the blood by Schmidt's method ; that is, precipitation by alcohol and subsequent extraction of the dried alcoholic precipitate by water. This ferment is identical with that of mammalian blood, and brings about coagulation in hydrocele, pericardial, and similar fluids, just as the ferment prepared from mammalian blood does.
7. Coagulation can be prevented by cold.

III.—The Proteids of the Plasma and Serum.

The proteids of the blood plasma are two in number, namely—hæmocyanin and fibrinogen. The blood serum contains only the former of these, hæmocyanin.

1. *Hæmocyanin.*—This is an interesting body, occurring pretty widely, distributed in various classes of the invertebrata (Cephalopoda, Gastropoda, Crustacea, Arachuida). The properties that have been hitherto ascribed to it are as follows :—

(*a.*) It gives the ordinary proteid reactions.
(*b.*) It coagulates by heat at about 68°-70° c.
(*c.*) It exists in two conditions, analogous to those of hæmoglobin ; viz., hæmocyanin, and oxyhæmocyanin, the former being colourless, the latter having a blue tinge.
(*d.*) Its absorption spectrum shows no bands, but only a cutting off of portions of both ends of the spectrum.
(*e.*) It contains a small quantity of copper, which seems to take the place of the iron of hæmoglobin.

In addition to these I have found :—

(*f.*) It is a proteid of the globulin class. This is shown by the following facts :—

(*i.*) It is precipitated by dialysing out the salts from the serum.

(*ii.*) It is completely but slowly precipitated by saturation with magnesium sulphate, completely and rapidly by saturation with sodio-magnesic sulphate, and incompletely by saturation with sodium chloride.

(*iii.*) It is incompletely precipitated in dilute solutions by weak acetic acid, or by a stream of carbonic acid.

(*g.*) It takes no part in the formation of the clot. Addition of fibrin ferment to a solution of pure hæmocyanin does not cause the formation of fibrin. Crustacean fibrin, moreover, contains no copper.

(*h.*) The temperature of heat coagulation I place at a rather lower point than that hitherto given, viz., 65° c.

2. *Crustacean fibrinogen.*—All the proteid matter in the salted plasma coagulates as in the serum at 65° c. Hence it is not possible to separate crustacean fibrinogen from hæmocyanin by a method of fractional heat coagulation.

It is precipitable by means of dialysis or saturation with various salts. Hence it, too, like hæmocyanin is a globulin. It, however, differs from hæmocyanin in its behaviour to one salt, viz., sodium chloride. It is completely precipitated from its solutions by saturating them with that salt. This furnishes us with a method of separating the two proteids. After shaking the plasma with sodium chloride for about three hours, a precipitate of proteid material is obtained. This consists of hæmocyanin and fibrinogen mixed together. This is collected on a filter, and the hæmocyanin can be washed away by saturated solution of sodium chloride, leaving the fibrinogen undissolved on the filter. On the addition of distilled water to this it dissolves, being enabled to do so by the salt adhering to it. A somewhat opalescent but colourless solution is thus obtained. On the addition of fibrin ferment to it, fibrin is formed.

Part IV.—Colouring Matters of the Blood.

These are two in number.

1. The blue colour associated with the proteid hæmocyanin.
2. Traces of a red pigment, tetronerythrin.

1. Hæmocyanin has already been treated of in the preceding part of this paper. The blue colour is due to the combination of oxygen with it. This occurs, as was first shown by Fredericq, not only in experiments with hæmocyanin outside the body, but also in the body itself; the blood going to the gills being colourless, and that leaving them having a blue colour.

There can be no doubt that hæmocyanin plays a part analogous to that of hæmoglobin in vertebrate animals; that is, it is the oxygen carrier. It is not, however, located as hæmoglobin in vertebrates is, in special corpuscles, but exists in solution in the blood plasma, as hæmoglobin itself does in the blood of many worms.

Hæmocyanin has been described as occuring in all decapod and other thoracostracous crustacea whose blood has been examined. While among the malacostracous crustacea, its place is taken by hæmoglobin, which is dissolved in the plasma as in the worms just alluded to.

Tetronerythrin, the red pigment.—In addition to the blue colour, there is also in solution in the blood plasma a small amount of a red pigment. In most specimens of fresh-water crayfishes, lobsters, and crabs, it is present in large quantities. The fact of its occurrence in the lobster is mentioned by Fredericq. In its identification I have received many valuable suggestions from Dr M'Munn of Wolverhampton. It is not a proteid, being readily extracted from the blood by means of alcohol. It belongs to the class of pigments known as luteins or lipochromes, and gives all the tests that Capranica and Schwalbe describe as characteristic of those bodies, viz. :—

1. It is soluble in alcohol, ether, chloroform, benzol, turpentine, bisulphide of carbon, and slightly in olive oil.
2. With sulphuric acid it gives a violet colour.
3. With nitric acid, an evanescent bluish green colour.
4. With iodine dissolved in solution of iodide of potassium, a violet colour. This test is only obtained readily after the saponification of the pigment by the addition of strong caustic soda to the alcoholic solution.

It is the same pigment that occurs in the shell of the animal, and which has received the name of tetronerythrin. Dr M'Munn has shown that it is probably formed in the liver of the crustacea; and on comparing spectroscopically the pigment taken from these three situations—the exoskeleton, the blood, and the hypoderm—they are seen to be identical. There is a small cutting off of the red end of the spectrum, and the blue end is cut off up to the E line, or a little on the red side of it. In a more dilute solution less of the red end is cut off, and a band in the region of the F line becomes detached from the large absorption of the blue end. This is not a very dark band, and in very dilute solutions appears only as an ill-defined shading.

It is a pigment that occurs pretty widely distributed in the animal kingdom. Merejkowski found it in 104 species of animals, vertebrate and invertebrate (*Comptes rendues*, tome xciii. p. 1029, 1881). He supposes it to have an important action in cutaneous respirations, on account of the large quantity in which it occurs in the gills. Oxidation and reduction produce, however, no effect on it when separated out from the parts in which it occurs. It becomes colourless when exposed for some time to the air, but this discolouration occurs equally well in a vacuum.

Its presence in the blood is interesting, as showing how it passes from the liver, where it is probably formed, to the surface, where it is probably used for respiratory or other purposes. Seeing how abundant this pigment is in the shell of nephrops, it is difficult to account for the small quantities in which it occurs in the blood. There are, however, many lobsters in the blood of which it occurs in equally small quantities. In these, as in many specimens of nephrops' blood, I at first thought it was absent; the alcoholic extract is colourless; still, on evaporating it down to a small bulk, it becomes of a faint orange red colour; and, later still, flakes of the pigment separate out.

General Conclusions.

The chief results of this investigation of the physiological and chemical properties of the blood of nephrops norwegicus may be summarised as follows :—

1. The spontaneous coagulation of the blood is not due to the formation of a mere coalesced mass of cells or plasmodium, but to the formation of a substance very like the fibrin of vertebrate blood entangling the blood corpuscles in its meshes.
2. The blood plasma contains two proteids—a fibrinogen, which is the precursor of the fibrin just alluded to; and hæmocyanin, a proteid with which copper is in combination, and which takes the place of the hæmoglobin in other animals as an oxygen carrier. In the reduced state hæmocyanin is colourless; in the oxygenated state, blue.
3. The blood corpuscles are amœboid, and resemble the white corpuscles of vertebrate blood. Like them, too, they furnish a ferment which is capable of bringing about the formation of fibrin in a coagulated liquid, *i.e.*, a liquid containing a fibrinogen, whether vertebrate or crustacean.
4. In addition to the blue colour due to oxy-hæmocyanin, the blood plasma contains a small amount of a red pigment called tetronerythrin; the same colouring matter as occurs in the shell and hypoderm. The small quantity in which this pigment is present makes the blood of nephrops contrast strikingly with that of allied decapods, in which, as a rule, it is present in abundance.

APPENDIX F.—No. XI.

FURTHER REPORT ON THE EXAMINATION OF RIVER WATER FOR MICRO-ORGANISMS. By W. S. Greenfield, M.D., Professor of General Pathology in the University of Edinburgh, and G. Sims Woodhead, M.D., Senior Assistant in the Pathological Department.

In the present report it is proposed to give some further information as to the progress of an investigation which has been conducted in my laboratory during the past few months, on the micro-organisms which occur in the water of various large rivers, especially those connected with fishing interests.

Owing to various causes it has not been possible to conduct the work without intermission, and progress has also been retarded by a necessary change of workers.*

It had been intended to give some fuller account of the progress of the investigation of each river. But when one came to put together the detailed notes of the observations, it was found that they were far too voluminous for publication, and whilst of great value to the investigator, they would be of little service to those not actually engaged in similar work. It was found, also, that they would require for their elucidation a large number of figures and plates.

It has been thought best, therefore, to state only some net results, which give but a small idea of the extent and complexity of the investi-

* During the summer the chief part of the practical work was carried on under my supervision by Mr Joseph Griffiths, M.B., who has since left for Cambridge University, and more recently Dr Woodhead has been continuing the work, which is still in active progress. It may be well to state that whilst the report is the joint work of Dr Woodhead and myself, I am alone responsible for the microscopic examinations and measurements.—W. S. G.

gation, for it has been necessary not only to carry on the research, but in the course of its progress to elaborate and control the methods by which such an investigation should be pursued. The time and labour which have been expended upon this tentative work have not been thrown away, but have led to results which will be of the greatest value, although at present these results may appear hardly commensurate to the labour. But the material accumulated will be of much value for future work. The methods to be employed have been thoroughly tested and simplified, so as to be of easy application in the future.

At the outset of the inquiry it was anticipated that a method would be discovered by which the mycelial fungi could be readily separated from the lower forms, such as torula, sarcina, and the various forms of bacteria, and that thus either class could be separately investigated, without regard to the others. This has not proved to be the case, except to a limited extent. Every sample of water contains many forms of these lower organisms, and it is necessary to isolate and study separately each individual form, in order to arrive at accurate results. Many can be separated with great facility, but others, owing to their slowness of growth, or the requirement of special conditions for their development, can only be isolated with greater difficulty. The methods by which this result has been attained will be described later, as they may serve for a guide to future observers.

The investigation being in great measure a novel one, it has been one great object to isolate and describe, as far as possible, all the organisms which have been met with, so that they may be readily recognised in future. And whilst a large number have been isolated and studied sufficiently for future recognition, each species is being further subjected to special investigation as to its reactions in various media, and under different conditions of growth, &c.

In the present report it is proposed to deal only with some of the bacteria and allied growths (sarcina, &c.), leaving the mycelial fungi for a future report. These latter require for their exact recognition a more exact study of the mode of fructification, &c., under various conditions; and whilst many of the commoner moulds of the classes Penicillium, Aspergillus, and Mucor have been easily recognised, others have not yet been identified.

As a preliminary to all investigations of micro-organisms in water, it is important to ascertain what is the number of bacteria or spores present in a given volume of water. This is not only valuable as a guide to the degree of dilution desirable for the further experiments, but it is also of the greatest importance in relation to the purity of the water and its comparative freedom from decomposing organic matter. Bacteria are always present in especially large numbers in those parts of rivers which are near the inflow of sewage, and their abundance serves in some degree as a test of the proportion of sewage contamination. A large amount of other dead organic material also affords a favourable nidus for their development. And there can be little doubt that apart from the direct power of producing disease, which is possessed by some forms, the presence of a large number of those forms which have for their especial property the production of decay and putrefaction of dead organic matter, is directly prejudicial to all the higher forms of animal life.

Bacteria can live on almost any dead organic material, and it is largely through their agency, as above stated, that such matter is decomposed and rendered available for further use. Moulds and allied genera, however, flourish most luxuriantly upon partially decayed matter or upon specially prepared food, hence they are much more vigorous where

decomposition has been commenced by bacteria, and where such decomposition has gone on for a long time. The presence of bacteria in waters is, then, a most important factor in connection with the presence of fungi in our fish streams. Firstly, as an index of the amount of organic matter present, and secondly, in connection with the action upon this organic material, before it can contribute readily to the nutrition of fungi.

How far this fact may have a potent influence on the presence and persistency of the salmon fungus (Saprolegnia) in some rivers, must be a subject of future investigation. In the water from the Tweed, which contained the largest number of bacteria, the salmon disease was prevalent in abundance.

For the purpose of determining the number of organisms present in a sample of water, Koch's plate gelatine method was employed. This has already been partly described.* It is based upon the fact that most common micro-organisms grow readily on a gelatinised broth, to which a certain quantity of dried peptone has been added. A definite quantity of water is mixed with a definite quantity of this gelatinised broth, previously liquefied by warmth, and the whole spread upon a glass plate in a thin uniform layer. The layer of jelly is kept under cover at a suitable temperature for from two to six days. The individual bacteria or other organisms are widely enough separated to ensure separate germination, and from each there develops a separate colony, which soon becomes sufficiently large to be seen with the naked eye.

In order to count the number of colonies, which corresponds, of course, to the number of bacteria or spores of other organisms present, a glass plate, upon which has been ruled with a diamond a number of lines dividing it into equal squares, is laid over the layer of jelly, and the number of colonies counted in each one of a number of squares. The total number of colonies, when divided by the number of squares counted, and multiplied by the number of squares which correspond to the total area of the jelly, gives the number in the quantity of water examined. We have, however, adopted a still more exact method, viz., to number the squares, and to count every one of them separately. In this way an absolutely exact result is obtained, and any error can be checked by counting the same square over again.

The number of organisms is usually calculated by taking as the unit one gramme of water (= 1 cubic centimetre at 18° c.). It is well, however, to use a smaller quantity than one cubic centimetre, and to determine the exact quantity by weight rather than measure. This is done by using uniformly a pipette of definite size, graduated in the following manner :—

A piece of filter paper was carefully weighed, and then five drops of water dropped upon it from the pipette to be used, and the whole weighed again. Five drops more were added, and the whole again weighed. After numerous repetitions of this process, it was found that with a uniform method the weight of five drops was so constant as to be perfectly reliable. In the case of the pipette used the weight of five drops was ·27 gramme (and the number of organisms per gramme was, of course, easily arrived at by multiplying by 3·7).

Although at first sight this method may appear rough, it has the great advantage of avoiding risks of other contamination of the water.

A more strictly accurate method is that adopted by Dr Winter Blyth, who takes a quantity of the water to be examined in a small drop bottle previously sterilised. The water and bottle are weighed, then a few

* For the exact details and an account of the precautions taken to ensure sterilisation and the exclusion of germs from the air, see Third Annual Report of Fishery Board for Scotland, 1885, p. 75.

drops are taken out with the pipette on the stopper, and transferred to the gelatine. The bottle is reweighed, and the weight of the water is obtained from the difference between the first and second weighings. But this method has also disadvantages in practice.

In addition to the estimation of the number of organisms in the water, the points of liquefaction of the jelly are counted. And, as a further step, separate cultivations from individual colonies can be obtained.

The following estimates will serve as illustrations of the results obtained:—

Sample 1 of Tweed water (from Pavilion at Melrose), examined the day after it was taken from the river. In water taken from near the bottom of the stream there were 780 points of growth or colonies in ·27 gramme, or 2886 centres per gramme of water. In water taken from near the surface there were 329 points in 0·27 gramme, or 1217 per gramme, giving an average of 554·5 per 0·27 gramme, or 2053 per gramme.

Sample 2.—In water taken from Drygrange there were 597 points in 0·27 gramme or 2209 per gramme at the first counting. Water taken from below mid stream, at the second counting of a similar sample of water, there were 603 points per 0·27 gramme, or 2232 points per gramme, giving an average of 600 points for 0·27 gramme, or 2222 per gramme.

Taking an average of the above countings, we find that Tweed water contains 575 points of growth or colonies in 0·27 gramme, or 2134 per gramme, each colony growing from a single bacterium or a single spore. In addition to these, there may be several forms which grow extremely slowly (so that they are not visible to the naked eye or with a low power magnifying glass within six days), and others which do not grow except under water.

Taking an average of the liquefying points, we find that there are 113 in 0·27 gramme, or 318 in each gramme of water. These liquefying points are probably for the most part due to bacterium termo and hay bacillus.

It has been found by repeated experiments in Berlin, London, and elsewhere, that good drinking water seldom contains more than 1000 points or colonies in a single gramme; in other words, that there are not more than 1000 bacteria or spores of fungi in each gramme. Looking at it from this point of view, the Tweed water is far from satisfactory, as in it we find during the month of March an average of no less than 2134 points per gramme. It is important to note the month or time of year in this connection, for in some experiments made last year in the Gesundheitsamt (Laboratory of the Board of Health Office), Berlin, on unfiltered river water, it was found that during the winter there were far fewer organisms than during the summer months (extremes, 685 in February and 3251 in October, giving a mean number of 1435 for the year), so that when the examination is continued we may expect to find a larger number of micro-organisms in the Tweed during the summer months.*

It may be pointed out that after filtration the Berlin river water showed an average of only 197 points of growth, 277 being the highest and 21 the lowest numbers recorded. This fact is well worth most careful consideration.

Another point to be carefully noted is the comparatively large number of organisms near the bottom of the stream as compared with the surface. This, of course, can be partially explained by the subsidence of particulate

* In order to an exact comparison a more rigid control of the precise length of time after taking the water from the stream is necessary. We were unable to obtain favourable enough conditions for these observations, which should if possible be done on the spot.

material, which, as it sinks, carries the bacteria, &c., along with it, but it is also to be accounted for in part by the fact that near the bottom there is almost invariably a larger quantity of organic matter, in addition to which bacteria develop much more rapidly when the fluids in which they are present are at rest.

Having thus completed the determination of the number of organisms present in each sample of water, the more difficult and prolonged work of isolation and separate investigation of the various species follows.

In many cases a direct transfer is made of some of the points of growth on the gelatin plate to separate tubes containing nutrient jelly—whence, after further growth, the cultivations can be successively inoculated into various nutrient media, and their properties studied.

But although the plate method, when it can be employed, is that best adapted for the separation of two or three forms of growth, it is not without serious disadvantages if used alone. Amongst other inconveniences, the thin layer of jelly is with difficulty kept moist in dry weather, especially in the summer; and when a large number of plates come to be dealt with, the moist-chamber accommodation is apt to become insufficient. Moreover, it is difficult to maintain an adequate degree of moisture without the aid of artificial heat. But there is another and still more serious disadvantage. It is, that when some common forms of bacteria, *e.g.*, bacterium termo, are present, they grow much more rapidly than some other bacteria which do not liquefy the jelly, and the spreading points of liquefaction run together and practically defy all attempts at isolation. There may be no difficulty in isolating three or four different species under such conditions; but when there are many different species, and they have not time to acquire distinctive characters, many must be entirely overlooked.

It is therefore desirable to employ some additional method which shall allow of a sufficient degree of germination to each species for the production of distinctive characters. This is obtained by the employment of some more solid soil which does not rapidly deteriorate, and upon which most of the known forms of bacteria and lower fungi grow readily. The cultivating soil which has been found most suitable for this purpose, and most readily prepared, is bread paste. Into flasks of about two inches diameter, carefully sterilised and plugged with cotton wool, bread crumbs are introduced in sufficient quantity to form a layer about half an inch in thickness, the surface being left as even as possible. The crumbs are moistened with distilled water, the flasks plugged, and the whole carefully sterilised by heating for some hours in a steam chamber at 100° C. Several dozen flasks can be prepared in this way at the same time with a small expenditure of labour, and they keep for many months in a moist condition.

If a very minute quantity of the water under investigation is placed upon the surface of the paste, the various organisms present grow upon and spread over the surface. The growth of some kinds, no doubt, impedes the growth of others, and in course of time one may entirely overmaster the rest. But during a certain time, in the struggle for existence, several species may go on growing side by side, and show distinctive features by which they can be partially recognised and separated. And in many cases a very long period, it may be months, elapses before the species which have attained a footing on the soil are entirely overcome by any one of their number.

During this period of growth several points of different colour and aspect may be distinguished side by side, and more or less merged in each other. These different points indicate different species, not pure,

but mixed with some others. If, now, as soon as these distinct growths can be recognised, a minute quantity is transferred from one of them to a fresh flask containing bread paste, a fresh cultivation may be obtained, in which one particular species preponderates, and by successive selections from cultivations some forms may be obtained nearly pure.

But having thus partially separated the several species into groups, it is necessary, in order to ensure absolute purity, to make fresh cultivations by the gelatine plate method, by which the two or three species present may now be more readily isolated.

An additional advantage of the bread paste method which must be emphasised, is the striking and characteristic appearances which many bacteria and other low fungi present as to colour and form when cultivated upon such a medium (as bread paste), an advantage possessed also in some degree by agar-agar jelly, and by potatoes, but far less readily and continuously applicable in the case of these media.

At the commencement of the investigation the mode of procedure is as follows:—

A long, thick sterilised platinum needle is dipped into the water to be examined, care being taken not to allow it to come into contact with the neck or lip of the bottle, the plug is then removed from the bread paste flask, and the minute droplet of water which collects at the point of the needle is allowed to come in contact with the bread paste, the flask being kept horizontal. The wire is then removed and the plug replaced. Several flasks are inoculated in the same manner in order to obtain as many varieties as possible. In flasks so inoculated various growths soon make their appearance. The mould fungi were very numerous, various species of Penicillia, Aspergilli, Mucors, &c., being found in considerable numbers. The determination of the species of these fungi is a matter of very great difficulty; a lengthened observation of their modes of growth, methods of fructification, &c., being necessary to do this at all accurately. Numerous forms have been separated and partially examined, but they have been set aside for future observation, as the species of Bacteria were so numerous and required so much of the time and attention that it was found impossible to include the fungi in the present report.

Bacteria.—Some of these made their appearance as naked eye growths in about three days, others took much longer, even as much as ten days, before they could be distinguished as definite growths on bread paste. In all cases it was found necessary to take cultivations from each growth as it made its appearance, for it was observed that some species, after once getting fairly under weigh, grew so rapidly as to supersede all other species in the flask, and it was not always the case that the one first seen was the species that eventually retained its ground.

By careful selection moderately pure cultivations may be obtained from these flasks. In fact, for microscopic purposes, these are all that are necessary, as where fairly successful cultivations are obtained, the typical form so far predominates that it can be readily distinguished from any impurities, such being present in much smaller numbers. For secondary bread paste cultivations, too, these are sufficiently pure, if it be borne in mind that the growth should be examined as soon as it makes its appearance. If it then corresponds in appearance with the part from which it was taken, we may conclude that a description of the naked eye characters of such a growth will serve all practical purposes. This method, however, is not alone sufficient, and wherever possible it is better to have the various forms perfectly isolated; for this purpose the gelatine plate method must be employed. This was subsequently done.

The method adopted is as follows. A bread paste flask in which are growing three or four different species is taken. Four sterilised plates are prepared;* at the same time eight quarter litre flasks are carefully cleaned, filled with distilled water, plugged, and then boiled for at least one hour. These are allowed to cool, and from one of the growths in the bread paste flask a small particle is transferred by means of a sterilised platinum needle to the distilled water. This particle is broken up and diffused through the water by shaking the flask thoroughly; 5 c.c. of this water is then removed with a sterilised glass pipette, and placed in a second flask, which is also thoroughly shaken; a test tube containing warm nutrient gelatine is then inoculated with five drops of this solution; the tube is carefully agitated until the water and gelatine are thoroughly mixed, care being taken that no air bubbles are included, and also that none of the fluid passes into the plug, and so to the mouth of the test tube. This mixture is then poured out on to the prepared glass plate, labelled and left in the sterilised moist air chamber for a day, after which it should be carefully examined every twelve hours. Some of the various species grow so rapidly, or liquefy the gelatine so suddenly, that unless this be done the growths in their immediate neighbourhood may be overlooked. The mode of growth is then noted, both as seen with the naked eye and under a glass of low magnifying power. Some species, as we have seen, liquefy the gelatine very rapidly, others but slowly, whilst others again grow in the gelatine without even softening it. Certain forms appear to bring about an evolution of gas, which may be seen forming a bubble when the organism is growing at some little depth in the substance of the nutrient jelly, and if the examination is being made near a window the image of the window may be seen reflected from the surface of the bubble. Other species occur as perfectly solid growths, the margins of which are sharply defined and smooth, or beautifully 'scolloped' or crenated, or there may be distinct rays shooting out from the central mass. Cultivations into nutrient jelly in test tubes are taken from these various centres of growth, and if time is an object bread paste flasks are also inoculated at once. Similar plate cultivations are made of the other points in the original flask, the different plates are compared, the preponderating forms of each noted, and from the data so obtained it might be stated almost precisely which forms on the plate correspond with the various forms in the flask. But, in order to ensure greater precision, the secondary cultivations, both in bread paste and gelatine, should be carefully observed and compared with the originals. After taking secondary cultivations, but not before, impressions of the points of growth on the plate surface may be taken by laying on a thin cover glass and then removing it carefully with a pair of forceps.† It will be found that the small groups of bacteria adhere to the glass, leaving depressions in the gelatine from which the bacteria have been removed. These are stained and set aside for examination. Other single points are also transferred from the gelatine to the glass cover-slip with a platinum needle, a hand lens or dissecting microscope being used to help in isolating the individual points of growth. By means of the above methods it has been possible to separate numerous distinct species, but it must be remembered that slight differences of colour are observed where masses of the same species of organism are growing in thin or thick layers, on different nutrient materials, or at different

* Third Annual Report of Scottish Fishery Board, p. 75. (*N.B.*—Somewhat larger plates, 4½ inches square, are now used).

† See *Lancet*, August 22, 1885, p. 336, "Notes from a Bacteriological Laboratory," by Edgar M. Crookshank, M.B., Lond.

stages of its development. Some, for instance, which are light in colour and moist when they first make their appearance, may become covered with a thin dry wrinkled pellicle, which is usually somewhat darker in colour. Further, several forms may have almost the same naked eye appearances when growing on one nutrient medium, though their behaviour on other media and their microscopic appearances may be quite distinctive.

For instance, on bread paste there grows a pink torula, a flesh-coloured bacillus, and a small bacterium, also flesh-coloured. Again, there is a yellow micrococcus amongst the species found, that cannot readily be distinguished from a yellow sarcina met with in both the Tay and Tweed waters, when the two are seen growing on bread paste. In the case of those organisms which liquefy gelatine, *e.g.* Bacterium termo, Bacillus subtilis, Violet bacillus, Yellow sarcina, and many others, there are usually distinctive features by means of which each may be recognised, especially if we can observe their manner of growth on other nutrient media. Up to the present only solid or jelly-like media have been used, but now that a number of pure cultivations have been obtained it will be necessary to observe their behaviour in fluid media.

Forms of Bacteria Observed.

The following descriptions will serve to indicate some of the various forms of bacteria and allied micro-organisms (torula, sarcina) which have been already isolated. Especial attention has been given to the Tweed water.

Great difficulty has been experienced in giving any adequate description of the colour and appearance of the organisms described. Thus in a description it is impossible to state the various shades or tones of colour, such as yellow. We have met with growths of all varieties of this colour, pale honey colour, bright and dull gamboge yellow, orange, lemon, chrome, and Indian yellow, and so on; and in some cases it has been only on seeing the growths side by side that a striking difference has been apparent. White, yellow, and brown are the preponderating colours, pink and red being next in frequency.

The only way in which this difficulty can be adequately met in a report is by a series of coloured drawings, which have not yet been completed.

In the microscopic examination, the method of preparation was uniform, and although the slight contraction of the protoplasm, and some other modifications, are produced by the preparation, it serves well for a relative comparison of different forms, both as to characters and size.

The examination and measurement was in all cases made with Powell & Lealand's 1-25th oil-immersion and Abbe's illuminating apparatus. The ocular micrometers employed were Verick's, giving a magnifying power of exactly 2000 diameters; and Zeiss's screw micrometer, which was used to control the results more exactly. It is necessary to mention these facts, as examinations made with lower powers (*e.g.*, × 850 or 1000) do not serve to determine with sufficient accuracy the points of difference of nearly allied forms.

It is proposed in a future report to give exact drawings to scale of the more important forms, but for the present it has been thought sufficient to state briefly the most striking characters and measurements.

Tweed.

The following are the more important of the bacteria which have been isolated from the Tweed water. Nos. 1 to 9 were specially observed in water taken from Abbotsford, Nos. 10 to 26 in water taken from various points in the neighbourhood of Melrose. Of course some forms are of frequent recurrence in the water wherever taken.

1. Orange red or orange yellow points growing on bread paste, either in thick moist patches or thinner dry scales, according to the amount of moisture in the bread paste.

Microscopically—Ovoid or short solid rods, ·5 to ·6 μ in breadth and 1 to 1·25 μ in length.

2. Brownish yellow growth, made up of micrococci, rounded or ovoid, ·35 to ·4 μ in diameter and ·6 μ in length.

3. There is also a growth, darker brown in colour. At first it is much lighter and yellower in colour. It is then a mass of considerable thickness, and is at this stage moist, and the colour of dark honey; but eventually it has the above appearance. Growth not very rapid.

Microscopically—Micrococci rounded or ovoid, ·5 in diameter, and as much as 1·25 in length in some cases.

4. Dark brown or snuff-coloured growth, of considerable thickness, especially around the point of inoculation. On its surface, which is moist or watery looking, there are, however, a few pale yellow patches. On the surface of this growth is, in some places, a peculiar dry wrinkled pellicle.

Microscopically—A bacillus. The individual rods, which measure ·5 μ in diameter and 1·25 μ in length. These rods are hollow, and have their ends rounded.

5. There is also a lighter, but dirty brown mass, which grows very rapidly and attains a considerable thickness, but in each there is a central depression (probably simply the point of inoculation). This growth is even more moist than the above (fig. iii.).

Microscopically—Bacillus; ·35 to ·4 μ in diameter, and 2 to 2·5 μ in length, forming filaments as much as 12 to 30 μ long, in which may be seen very distinct spore formation, the spores being ovoid and wider than the rods; ·6 μ broad and ·8 μ long.

6. A moist cream-coloured (slight brown tinge) growth, spreading rapidly over bread paste. Thickest in the centre, where also it is most moist and watery looking.

Microscopically—Bacteria, somewhat spindle-shaped, with bluntly pointed ends, and possibly ciliated; ·5 to ·6 μ in diameter, ·8 to 1·5 in length.

7. Pale orange yellow growth. Moist and of considerable thickness, not extending much at the margins, but evidently increasing considerably in thickness. Extending by pushing out little thick tongues sometimes, but usually increasing principally in thickness.

Microscopically—Short bacteria, the shortest being ovoid, others distinctly rod-shaped, measuring ·5 to ·6 μ in breadth; ·7 to 1·5 in length.

8. Yellowish growth, of considerable thickness, in the form of patches, rounded, elevated, moist, which run into one another, but at their free margins are crenated.

Microscopically—Ovoid micrococci, mostly in pairs; ·5 to ·6 μ.

9. Brown moist growth, very similar to that of No. 6, but browner and with a faint pink tinge running through it; spreads rapidly in both extent and thickness.

Microscopically—Rods straight or slightly curved, of uniform thickness; ends blunt. Rods appear hollow, and are much more hyaline than No. 7. Some contain small round dots at the ends.

10. Dirty, yellowish white, moist points, slightly raised from the bread paste; paler towards the centre, and shading off to yellow at the margin.

Microscopically—·7 μ in diameter, 1·6 to 2 μ in length; in some cases forming filaments 8 to 12 μ long, in which are seen ovoid spores; ·8 μ in breadth and 1 μ in length.

11. Light cadmium yellow points or mammillæ growing on the surface of the bread paste. These points look hard and glistening; they do not look moist, but polished.

Microscopically—An extremely delicate bacillus, ·3 to ·5 μ in breadth, ·1 to 1·8 μ in length, with many free spores slightly wider than the rods, and ovoid; ·4 to ·45 in breadth and ·5 to ·6 in length. Some longer filaments, from 4 to 6·5 μ in length.

12. Thick dirty brown, almost coffee-coloured or brownish-red mass, which has invaded every particle of the bread paste, both on upper and lower surfaces. In the earlier stages this mass is described as watery-looking or translucent, but examined later it is covered with a thin dry wrinkled skin.

Microscopically—A large solid bacterium, composed of short slightly curved rods. These shorter rods are pointed at the ends, and apparently ciliated; ·8 to 1 μ broad and 2, 2·5 to 4 μ long.

In the longer wavy filaments there is marked narrowing at the points where division is taking place. No evidence of spore formation.

13. Light brown, soft moist growth, which covers almost the whole of the bread paste surface; outlines very irregular, with a peculiar racemose arrangement at the margin. Near the centre this growth is of considerable thickness; at one or two points there is a faint chrome-yellow tinge, but only in certain lights. Surface slightly mamillated.

Microscopically—Oblong micrococcus: ·5 μ broad and ·7 long; single or double, the pairs measuring 1·2 in length.

Repeated in another flask, but rather smaller—·3 μ broad, ·5 μ long.

14. A violet-coloured growth, not yet obtained perfectly pure. It has so far been mixed with *B. subtilis.* It made its appearance in the first bread cultivations from Tweed water, and from these inoculations were taken into other flasks, and upon potatoes. In all cases it preserved the same appearance. It grows pretty rapidly at first as a violet mass, slightly elevated beyond the surface of the bread paste or potato. Some of the points are deep violet in colour, and are moist and glistening; others are much paler (due probably to presence of *B. subtilis* or *B. termo*), but have the same moist, smooth, glistening appearance.

In gelatine it grows very rapidly, especially near the surface, where it is more directly in contact with the air. Liquefaction takes place within twenty-four hours, the liquefied area forming a kind of cone, with a series of small bells or beads near the apex. The violet growth made up of the bacillus masses sinks to the bottom, where it forms a most beautiful object.

Microscopically—A granular bacillus, ·6 μ broad and ·8 to 1·6 long, in which may be seen spore-formation.

15. Another brown growth, with a slight yellow tinge. Small, moist; not growing very rapidly.

Microscopically—An extremely delicate hyaline and granular bacillus, ·2 μ in diameter, and of various lengths.

16. An orange or gamboge-coloured growth, in the form of a mass of considerable thickness, spreading also at the margins. The colour is

deeper where the growth is thickest, *i.e.*, near the centre, and lighter at the margins. The mass as a whole is moist, but it is covered with a delicate dry film. Slightly mamillated.

Microscopically—Ovoid micrococcus. Many partially divided, resembling short rods, but nearly all can be resolved. ·4 μ broad and ·6 to ·65 μ long.

17. A beautiful moist sulphur or cadmium-yellow growth of considerable thickness, which spreads pretty rapidly over the surface of the bread paste, and has a number of small mamillated projections above the general surface of the growth.

Microscopically—A torula, the cells of which spherical, ovoid, or oblong, averaging ·8 μ in transverse diameter and 1·4 μ in length.

18. In a large number of flasks there is a flesh-coloured very watery mass, which grows with extreme rapidity. It spreads rapidly at the margin, and may attain a considerable thickness. When it dries at the margins other forms do not encroach upon it.

Microscopically, it is a slender bacillus, ·3 to ·4 μ in diameter and 1·2 μ in length, forming dense masses of filaments, with some round spores ·4 μ in diameter, the formation of which is well seen. Differs from No. 11 (yellow bacillus) in the much more hollow character of its filaments, the hyaline masses which they form, and the mode of spore formation.

19. A second very similar but somewhat drier flesh-coloured mass was also found.

It consisted (microscopically) of very minute bacteria ·2 to ·3 μ in diameter, and 1·3 to 2 μ long, packed in dense masses. No longer filaments seen.

20. A third flesh-coloured growth consists of oblong micrococci, mostly in pairs ·5 μ in diameter and ·8 to 1 μ in length, or actively dividing.

21. There is also another yellow growth, somewhat similar in its naked eye appearances to No. 8, but microscopically it is seen to consist of very minute delicate bacilli, ·2 to ·25 μ wide and ·8 to 1 μ long. The outlines are very faint, and distinct spore formation may be seen. The rods are straight or slightly curved.

22. Light brown, moist growth.

Microscopically—Short solid rods with rounded ends, very various in length, 1 to 2 μ, and about ·5 μ broad. Seen to be dividing actively, but with no spore formation.

23. A pink growth found in some of the flasks, almost like pink coral, growing on the surface of the bread paste. It is delicate rose-pink, dry or moist according to the medium on which it is inoculated. It may attain a considerable thickness, when the margins are usually scalloped.

In gelatine the characteristic pink growth is found only at the free surface. Along the track of the needle the growth is less luxuriant and is dull grey, in which a very delicate pink shade may be made out. It does not liquefy gelatine.

Microscopically—A torula, the cells of which are ·6 μ to 1 or 1·25 μ in diameter.

24. There is also a yellow torula growing in some of the flasks. In this form the cells are more rounded, and measure only ·5 to ·65 μ in diameter.

25. One of the most common if not the most common of the putrefactive bacteria appears as a glistening grey layer on the surface of the bread paste, on which it grows with extreme rapidity. This moist grey layer gradually becomes darker in colour. When inoculated into gelatine it liquefies it very rapidly, especially at the upper part of the track of the needle. A funnel-shaped depression is formed containing a slightly turbid

fluid tinged with green. Gradually the upper layers of gelatine are completely liquefied, and the liquid is of a more distinctly green colour, which later becomes deep citron yellow. Growing on bread paste, it gives rise to a strong putrefactive odour.

Microscopically—·5 to ·7 broad and 1·5 long. Bacterium termo.

26. A very pale, almost (oil paint) white, opaque growth, which extends over and through the bread paste, making its appearance on the under surface, discolouring it somewhat. On the surface of this growth there is formed after a time a darker, thin, dry, wrinkled film, which gradually becomes thrown into folds. This growth spreads rapidly over the whole surface of the bread paste, and ultimately obscures most other forms which may have started with it.

Inoculated into nutrient gelatine an opaque white line is seen along the track of the needle. Liquefaction commences at the surface, and slowly following this track works downwards, a thick, dull white precipitate being deposited at the bottom of the liquefied portion, which is usually slightly opaque. When a drop of water has been shaken up with the nutrient jelly and left in the test tube, the presence of this same organism may be suspected when we see developed small, clear, rounded spaces in the jelly, with a dull white deposit at the lowest part of the globule. It causes liquefaction of the jelly more slowly than bacterium termo (No. 22).

Microscopically—A bacillus about 2 μ in diameter and from 6 to 8 μ long. Sometimes seen in longer threads. Distinct spore formation, the spores appearing at smaller parts of the rods.

TAY.

The following are the most important species which have been isolated from Tay water:—

1. A brilliant moist cadmium yellow growth which spreads somewhat rapidly over the surface of the bread paste, especially if the surface be moist. At the point of inoculation the growth is thickest, and at the centre of the growth the bread paste is completely covered, but nearer the margins the yellow growth runs in the fissures or depressions where the moisture is collected.

In gelatine, on the third day, there is a grey point of growth on the surface, but as yet no liquefaction. On the seventh day it has assumed a yellow tinge, and the gelatine is slightly softened, allowing the surface growth to sink into a kind of cup.

Microscopical Characters—It consists of rounded cells, single or double or budding, ·7 to ·8 μ in diameter and ·8 to 1 μ in length. A yellow torula.

2. Light brown mass, growing as smooth light brown or fawn-coloured elevated patches on the surface, of which there is some slight roughening. Some of these patches grow directly on the bread paste, but others are seen on the surface of the yellow growth above-mentioned that occurs in the same flask.

When inoculated with gelatine it does not give rise to liquefaction at the end of seven days. There is simply a small pearly-grey growth at the surface, somewhat thickened at the margins, which are scalloped. A very delicate growth along the track of the needle.

Microscopically—A minute rounded micrococcus ·35 to ·4 μ in diameter.

3. White oil paint mass mamillated with pure white points growing on the surface. Surface smooth and glistening, but dry.

Bread paste around the growth is deeply discoloured. Shining through thin parts of growth this appears of a bluish-green tinge, but when uncovered by the growth it is a leaden-grey with a slight tinge of green.

Microscopically—It consists of ovoid micrococci somewhat variable in size, ·5 μ broad by ·6 μ long.

4. Moist orange growth, somewhat roughened on the surface, growing most readily in the moister parts of the bread paste; in fact making very little headway on a dry surface. It follows the moist grooves, where it appears much deeper in colour. Paler because thinner on the slight elevations.

Microscopically—Ovoid micrococci ·35 μ broad and ·45 long; usually arranged in pairs, but some are single, and others are in chains.

5. Light yellow growth with smooth moist surface, growing rapidly, and extending over surface, but not passing the under surface of the bread paste.

Microscopically—Consists of ovoid cells, ·7 μ by ·8 to 1 μ, arranged in pairs, clusters of four, or in masses. A sarcina.

6. Thick, moist, cream-coloured or almost fawn-coloured growth, made up of a series of mamillæ or small flattened nodules growing in thickness as well as laterally.

Microscopically—It consists of zooglea of micrococci averaging about ·5 μ.

7. A green film, somewhat moist and glistening, not growing very rapidly, resembling nothing so much as a smear of olive green paint on the surface of the bread paste.

Microscopically—It consists of delicate bacteria somewhat granular and often slightly bulged in the middle. Transverse diameter, ·3 to ·35 μ; length, 1·2 to 1·6 μ.

Spore formation in various stages at end of rods. Oval spores, ·4 μ broad and ·65 μ long.

8. Yellow or orange-red mass, growing especially where there is an accumulation of moisture, and therefore in the sulci between the crumbs of bread paste, but covers almost the whole surface.

In gelatine it appears to have a slight pink tinge when examined by reflected light, but is orange as seen by transmitted light. Along the track of the needle it grows as a pale grey streak made up of minute spherules. It does not cause liquefaction.

The cover glasses used in this case were too thick, and it was found impossible to view the $\frac{1}{25}$th in objective, but the organism appeared to be a short ovoid or round-ended bacterium.

9. Light brown growth, in which there is a pink tinge, forming a thick, dark flesh-coloured mass, the surface of which is dry and glistening, as though a thin film had been dried and then varnished. No discolouration of the bread paste.

Microscopically—It consists of small delicate granular and somewhat varicose bacteria, ·5 μ in breadth and 1·6 to 2 μ in length.

10. There is also a much darker brown, very like the above, except in colour.

Microscopical characters—A large bacillus, with rounded ends, ·7 to ·8 μ in diameter and 2 to 3 μ in length.

Spores ovoid, ·7 μ broad and 1 to 1·2 μ long.

APPENDIX F.—No. XII.

REPORT on the PHYSICAL OBSERVATIONS made for the FISHERY BOARD for SCOTLAND during the Autumn of 1883 in the Moray Firth. By John Gibson, Ph.D., Senior Demonstrator of Chemistry, University of Edinburgh. With Plates VI. and VII.

Early in August 1883 I was invited by Professor Cossar Ewart to join a scientific expedition to the Moray Firth, and to carry out physical and chemical work in connection therewith. As only a very few days were at my disposal it was not possible to make preparations for any very extended or systematic series of observations. The expedition was in fact of a tentative nature, and I therefore devoted myself chiefly to laying down lines for that future work for which it was then hoped the indispensable facilities would be granted by Government in the year following.

The delay in drawing up this report has been in part caused by circumstances beyond my control, but has mainly arisen from my having been led into a somewhat extended research, in order to ascertain the degree of accuracy of the elegant method for the determination of specific gravities of liquids originally due to Sprengel. (*Chem. Soc. Jour.* [2], xi. 577). The greater portion of this report consists of a description of a special adaptation of this method to hydrographic work, and of a discussion of the results which I have obtained by it.

The most of the work accomplished by me during the expedition was carried out on board H.M.S. 'Jackal,' and consisted chiefly of temperature observations and in the collection of samples of water at different points or stations, as opportunity presented itself, between the intervals of the dredging, which occupied the greater part of each day, while the expedition lasted.

Column three of Table I. gives the number of the station as marked upon the Admiralty Chart used during the Expedition.

Station means simply place at which a halt was made in order to let down the dredge or trawl, to take temperatures, or to collect samples. The position of each station was determined as closely as possible by cross bearings. The principal stations are indicated in the chart (Plate VII.).

For these I am indebted chiefly to the kind courtesy of Lieutenant Steele of H.M.S. 'Jackal.' During the latter part of the Expedition they were determined by Mr J. A. Macdonald, in command of the Fishery Board cruiser 'Vigilant,' on board of which vessel the latter part of the observations, viz., those taken from September the 11th to September 21st inclusive, were made. To him also I am much indebted for the assistance which he at all times so readily gave, and for the interest which he took in the work.

The temperatures were taken partly with ordinary maximum and minimum thermometers (17, 18, and 19 in Table I.) by Cassella, and belonging to the Admiralty. By September 5th I was able to use one of Negretti and Zambra's reversing thermometers (*R*, in Table I.), fitted in Commander Magnaghi's frame. All the thermometers used were carefully compared with a Kew standard, but within the range of temperature I met with, no errors were detected sufficient to justify the application of any correction. The temperatures given in Table I. are therefore those actually observed and noted down at the time.

The depths given in column four were obtained by the sounding line, and do not pretend to any great accuracy.

This table requires no farther explanation.

TABLE I.

Date.	Time.	No. of Station.	Depth in Faths.	Thermometer.	Surface Temp.	Bottom Temp.	Thermometer.
1883.							
August 14, .	...	9	9	19	54·7	52·8	19
" " .	...	10	9	19	54·	52·7	19
" " .	...	11	11	19	54·7	52·8	19
" " .	...	12	19	...	...	52·	...
" " .	...	13	21	...	...	51·8	19
" 15, .	...	14	4	...	55·	54·	19
" " .	...	15	16	...	53·	52·5	...
" " .	10.25 a.m.	"	12½	...	54·	52·8	...
" 16, .	10.55 a.m.	16	10	...	53·8	53·	...
" " .	...	"	13	...	53·	53·	...
" 17, .	1.15 p.m.	17	13	...	54·	53·	...
" " .	...	18	20	...	53·5	51·	..
" " .	...	19	38	18	52·5	51·8	...
" " .	...	20	38	18	...	52·	...
" " .	...	21	...	19	52·9	51·9	...
" " .	...	22	...	...	...	51·5	...
" " .	...	23	38	...	...	52·	...
" 18, .	4.30 a.m.	24	25	19	53·	52·5	...
" 20, .	1.0 p.m.	25	8	19	54·3	53·7	...
" " .	2.30 p.m.	26	12	19	56·	53·7	...
" " .	4.30 p.m.	27	6¾	18	54·	54·1	...
" 21, .	9.20 a.m.	28	4½	19	54·6	53·3	18
" " .	10.30 a.m.	29	...	18	54·	54·	19
" " .	...	30	...	...	...	...	...
" " .	11.45 a.m.	31	...	18	54·8	...	...
" " .	...	"	4	...	54·8	53·8	19
Sept. 5, .	...	51	6	...	...	54·	R.
" " .	...	52	13	...	52·5	54·	...
" " .	...	53	22	...	54·	53·	...
" 6, .	12.15 a.m.	54	23	...	53·	53·	...
" " .	2.0 p.m.	55	24	...	52·8	53·	...
" " .	3.0 p.m.	56	23	...	53·5	53·8	...
" " .	4.0 p.m.	57	...	...	52·5	52·5	...
" " .	...	58	26	...	52·5	52·7	...
" 7, .	10.50 a.m.	59	38	...	52·3[1]	52·7	R.
" " .	11.50 a.m.	60	...	...	52·8	52·5	...
" 12, .	...	"	...	...	...	...	...
" 11, .	10.30 a.m.	61	14	...	52·7	52·5	...
" 11, .	11.45 a.m.	62	8	...	53·	52·6	...
" 12, .	11.45 a.m.	63	38	...	52·8	52·8	...
" " .	8.15 p.m.	64	...	...	52·5	52·8	...
" 13, .	11.40 a.m.	65	22½	...	53·8	53·	...
" " .	2.30 p.m.	66	24	...	54·2	53·	...
" " .	8.50 p.m.	67	...	...	...	53·	...
" 14, .	2.0 p.m.	68	8	...	55·1	53·	..
" " .	3.35 p.m.	69	15	...	56·	53·	...
" " .	...	70	...	...	55·1	53·1	...
" 15, .	3.0 p.m.	71	...	...	54·5	54·	...
" " .	4.45 p.m.	"	...	...	54·5	55·1	...
" " .	3.30 p.m.	72	3	...	55·	54·5	...
" " .	4.20 p.m.	"	...	...	55·	55·	...
" " .	...	73	...	...	55·3	55·3	...
" " .	...	74	1	...	55·	55·	...
" 16, .	10.0 p.m.	75	...	...	...	54·	...
" 17, .	1.20 a.m.	"	...	...	...	54·8	...
" " .	6.10 a.m.	76	14	..	54·4	53·8	...
" " .	8.30 a.m.	77	...	...	54·6	54·	...
" " .	...	78	...	...	54·1	54·1	...
" " .	...	79	...	...	...	...	...
" " .	4.0 p.m.	80	3½	...	55·	55·	...
" "	2.30 to 4.30 p.m.	81	...	...	...	...	...
" " .	...	82	...	...	...	...	...
" " .	...	83	...	...	...	...	...
" 18, .	10.0 a.m.	84	...	R.	55·8	55·3	R.
" 18, .	7.30 p.m. to	"	...	...	...	57·1 Max.	17
" 19, .	9.30 a.m.	"	...	...	...	55·3 Min.	
" 20, .	9.0 p.m.	"	...	...	...	54·2	R.
" 20, .	9.0 p.m. to	"	...	...	...	55·2 Max.	17
" 21, .	2.50 a.m.	,	...	...	...	53·8 Min.	

Collection of the Samples of Water.

The samples were collected by means of the slip water-bottle devised by Mr J. Y. Buchanan. The construction and working of this water-bottle, which is made of brass, will be readily understood by reference to figs. 1 and 2 Plate VI.

The body A consists of two discs *a* and *a'*, separated by three radiating brass plates *cc*. About quarter of an inch of the upper outer edge of the disc *a* is cut away, and its place taken up by a ring of india-rubber, indicated by the shaded line *g*. On its lower surface the disc *a*, which is perforated in the centre, carries a stopcock *b*, *b'* being a small plug attached to the bottle by a short piece of chain, to prevent any mud from lodging in the stopcock, should the water-bottle accidentally touch the bottom. The disc *a'* carries on its upper surface a hollow dome *d*.

The other part of the apparatus consists of the hollow cylinder B, which is first strung on to the line, to which the body A is then attached by means of a ring. Holding the cylinder B in the hand, the body A, with a heavy weight attached, is let down to the desired depth. When this has been reached the cylinder B is allowed to run down the line, its lower edge ultimately coming to rest on the india-rubber ring *g*. During the descent of the cylinder B, free circulation of the water takes place through the ring of holes near its upper extremity. The water contained by the cylinder B, at the moment of its reaching A, is expelled upwards by the dome *d*, which finally closes the holes, and thus prevents the escape of water while hauling up. After removing the plug *b'*, the water thus collected can be run out through the stopcock.

The working of this ingenious though simple contrivance is thus a very easy matter. With proper care, and by rejecting the sample whenever any displacement of the rubber or hollow cylinder is noticed, very reliable results may be obtained.

The samples collected were in most cases bottom samples; that is, samples collected at about one fathom above the true bottom. The surface samples were collected at about one fathom below the true surface.

Preservation of the Samples.

I at first intended to determine the specific gravities of the samples within a few days of their collection, and for this purpose brought a balance with me to the little station-house of the Expedition.

Practical difficulties, however, which I need not detail, stood in the way of the attainment of the necessary conditions for accurate weighing, and I therefore, after several unsuccessful attempts, reluctantly gave up this part of my original plan.

I had taken with me a not very large stock of glass stoppered bottles of about 750 c.c. capacity, but when I saw that the samples would have to be kept a considerable time before being examined, I discarded the glass stoppers, and adopted the following method in order to prevent loss by evaporation. The carefully cleaned bottle was rinsed out several times with small quantities of the sample of water, run out direct from the slip water-bottle, and then filled up nearly full. A carefully selected ordinary cork, well moistened with some of the sample, and covered with a piece of pure thin sheet rubber similarly moistened, was then inserted well into the neck of the bottle. The cork and rubber were then cut flush off with a sharp knife, and the entire mouth of the bottle covered with a quantity of fine sealing-wax. This method, which is recommended by Bunsen for the pre-

servation of samples of mineral water, is superior, I believe, to anything short of hermetical sealing.

During the last few days I was forced to use bottles of a different description, my stock having run out. The samples from stations 80 and 84 were collected in black pint bottles, and closed in the above manner. The samples from stations 69, 70, and 73 were collected in wide-mouthed bottles having good glass stoppers. A layer of sealing-wax covered the whole of the upper surface of the flat stoppers, which were, moreover, covered and held down with a piece of oiled silk firmly tied round the neck of the bottle.

Method for the Determination of the Specific Gravities.

In choosing a method by which to determine the specific gravities, I was guided by the following considerations:—

All methods involving corrections, based on observations of the expansion of sea water by heat, are liable to serious objections. In the first place, the observations as yet made, though numerous and elaborate, do not agree sufficiently with each other. In the second place, all such observations have been made either with sea water, or with sea water diluted with pure water.

Now the samples which I had collected were for the greater part largely diluted with river water, the character of which is very imperfectly known; and thinking it a matter of great interest to ascertain whether the brackish waters of the Moray Firth differ appreciably from sea water diluted with pure water, it seemed to me improper to use any method involving the assumption that the coefficient of expansion by heat is identical in both cases.

Now the only way to avoid the necessity for such corrections, and at the same time to obtain results strictly comparable with each other, is to exclude altogether the influence of difference of temperature by comparing the different waters with each other, and with pure water at one and the same temperature throughout.

After some trials, I resolved to determine at 0° C. the specific gravities of the samples I had collected, and to employ for this purpose the elegant form of pyknometer devised by Sprengel. Although this apparatus is well known, I may be permitted to give a short description of it, for the purpose of making my mode of working intelligible.

It consists simply of a U tube, the open ends of which terminate in two tubes of narrow bore, bent at right angles in opposite directions.

The U shape is adopted for the sake of presenting a large surface, and thus rendering the instrument sensitive to changes of temperature.

One of the narrow terminal tubes is drawn out at the end to a fine capillary; the other, and wider terminal tube, has a fine mark etched on it, about an inch below the bend.

For brevity I shall, in what follows, refer to the apparatus simply as *the tube*, and to the narrow-bore terminal tubes as the *capillary terminal* and *wider terminal* respectively.

In order to fill the tube the wider terminal is dipped into the liquid, and suction applied to the capillary terminal.

The level of the water in the wider terminal can be adjusted to the mark by applying a piece of blotting paper to the capillary terminal.

The great advantage of this form of apparatus is that, after being filled with liquid at a given temperature, it may be allowed to assume the temperature of the balance before weighing; for, as the liquid and tube

expand or contract with changes of temperature, the level of the liquid in the wider terminal rises and falls, the capillary terminal remaining full all the while, so that none of the liquid is expelled unless the expansion is so great as to cause the liquid to more than fill the whole of the wider terminal.

My reasons for preferring this method were the following:—

In the first place, the results were sure to be at least as accurate as those obtained by any other method hitherto adopted for the purpose. They would, moreover, be free from the sources of error attaching to the determination of the coefficient of expansion of sea water, and from any doubt as to the applicability of such determinations to the individual samples. Finally, the results themselves, apart from any value they might have as bearing upon the hydrography of the Moray Firth, would have considerable interest, as furnishing a severe test of the accuracy and general value of the method.

The mode of working was as follows:—The tubes, which were of not less than 20 c.c. capacity, were first thoroughly cleaned by repeated rinsing with distilled water, and, when necessary, with a little dilute hydrochloric acid. They were then carefully dried inside by placing them in hot distilled water, and then passing a current of pure dry air through them. Some time after every sign of moisture had disappeared they were taken out, carefully wiped with a fine old linen handkerchief, and allowed to stand for at least an hour in the balance-room before weighing.

They were next filled with pure water, by dipping the wider terminals into the water and connecting the capillary terminals with a water suction-pump, by means of a piece of black crowquill india-rubber tubing. The white vulcanised rubber balls and tubing usually supplied for this purpose are quite unsuitable, as it is almost impossible to prevent some of the loose adherent matter, with which such rubber is weighted, from entering the tubes.

The tubes having been filled considerably over the finely etched marks on the wider terminals, were placed four, six, and even eight at a time in a semi-solid mixture of pounded ice and water, contained in a tub provided with a false bottom of perforated lead, beneath which was a layer of ice. Without this false bottom perfect uniformity of temperature from top to bottom could not be attained whenever the surrounding temperature was much above 0° C. The temperature of the ice and water surrounding the tubes, which latter were always placed so as to be at least 4 inches from the side of the tub, never varied perceptibly during the process of cooling down to 0° C., although the thermometer employed was a Kew standard, divided into half degrees Centigrade of nearly 2·4 mm. in length.

The tubes while in the mixture of ice and water were supported in cylindrical cages of widely perforated zinc. Each of these cages was capable of supporting two or three tubes, and as they could be moved freely through the ice and water, local differences of temperature were easily avoided.

The level of the ice and water was kept about an inch above the etched marks on the wider terminals. As soon as the level of the water in the wider terminal of a tube became constant, a piece of blotting paper was applied to the capillary terminal, and in this manner water was drawn off until the level in the wider terminal was only slightly above the etched mark.

After a few minutes the tube was slightly raised by means of the attached platinum wire, so as to bring the etched mark just above the level of the ice and water.

As quickly as possible water was drawn off as above, until the lower edge of the meniscus coincided with the mark. The tube was then lowered, and allowed to remain for a few minutes lowered in the ice and water, when if, as was almost invariably the case, the level of the water remained constant it was taken out and suspended for ten minutes in pure water having the same temperature as the room, then carefully wiped dry and allowed to stand in the balance-room for an hour before weighing, the open ends being loosely closed with small glass caps.

The whole series of operations was then repeated, and if two weighings agreed to within 0·5 mgr., the mean of the two, after deducting the weight of the tube, was taken as the uncorrected weight of distilled water. With proper care the difference between any two such weighings was well within the above limit. When the difference was greater than 0·5 mgr. the determination was repeated. In such cases the difference was almost always much greater than 0·5 mgr.; varying from about 0·8 mgr. to 2 or 3 mgr., and was easily traceable to the following source of error. If the neck of the small cap be too narrow, it is not easy to avoid touching the glass with the end of the capillary terminal, in which case some of the water flows out by surface attraction, and spreading over the inside and along the neck of the cap gives rise to considerable loss by evaporation. On one occasion differences greater than 0·5 mgr. were observed, and traced to a want of care in keeping the temperature of the bath constant. Such results were allowed no influence in determining the mean.

The operations were exactly the same when the corresponding weights of sea water were determined. The tubes were rinsed out with the water in question not less than seven or eight times, using small quantities of about 5 c.c., and allowing the last drop to drain away each time before proceeding with the next rinsing.

Before proceeding to the discussion of the results obtained in the above manner, a few words are necessary on the balance and weights employed, on the mode of weighing, and on the reduction of the weighings to vacuo.

It would be out of place to enter into a detailed description of the balance which I used during the whole of this investigation. It is enough to say, that it was specially constructed for me by Oertling of London on lines laid down by Professor Dittmar, one of the first authorities on chemical balances. In an elaborate report upon this instrument, Professor Dittmar found the delicacy of the balance, even when at the maximum, to be practically independent of any charge up to 200 grammes, and such that the probable error of a weighing executed in the ordinary manner was only $\pm 0{\cdot}007$ mgr.

By taking the mean of six individual determinations as obtained by seven readings of the excursions of the needle, the probable error was reduced to $\pm 0{\cdot}003$ mgr.

In summing up his report Professor Dittmar remarks: 'This is by far 'the finest balance that ever passed through my hands.'

The balance was repeatedly tested during the course of the investigations, and the results fully corroborated this estimate. I gladly avail myself of this opportunity to thank Professor Dittmar for the many valuable suggestions he has from time to time made to me.

The weights employed, also made by Oertling, were of platinum, and were compared with each other, and the errors determined, before the commencement and at the end of the investigation. On every occasion on which the balance was used the zero point was redetermined, and in each individual weighing not less than five excursions of the needle were noted, not including the first, which was always neglected. I feel certain, there-

TABLE II.

		Distilled Water.				Sea Water.				Uncorrected Specific Gravities.			Corrected Specific Gravities.			
Number of Tube.	Contents of Tube.	Observed Weights.	Difference in mgrms.	Weights *in vacuo*.	Difference in mgrms.	Observed Weights.	Difference in mgrms.	Weights *in vacuo*.	Difference in mgrms.	Uncorrected Specific Gravity.	Difference in 5th place.	Average.	Corrected Specific Gravities.	Difference in 5th place.	Average.	Difference in the 5th place between the Average Uncorrected and Corrected Specific Gravities.
I.	Distilled water,	29·06889 29·06856	·33	29·10237 29·10221	·16	...	...	...	...	...	...	...	...	...	...	...
,,	Station 70, surf.,	...	...	...	...	29·76012 29·76027	·15	29·79368 29·79413	·45	1·023780 1·023785	0·5	1·023782	1·023758 1·023770	1·2	1·023764	1·8
,,	St. 21, near bott.,	...	...	...	...	29·88799 29·88837	·38	29·92193 29·92231	·38	1·028183 1·028193	1·0	1·028188	1·028164 1·028177	1·3	1·028170	1·8
,,	St. 91, bott.,	...	...	...	...	29·92717 29·92671	·46	29·96105 29·96059	·46	1·029530 1·029515	1·5	1·029522	1·029508 1·029494	1·4	1·029501	2·1
II.	Distilled water,	27·68649 27·68634	·15	27·71849 27·71834	·15	...	...	...	...	...	...	...	...	...	...	...
,,	St. 71, surf.,	...	...	...	...	28·40028 28·40049	·21	28·43225 28·43234	·09	1·025784 1·025793	0·9	1·025788	1·025755 1·025757	0·2	1·025756	3·2
,,	St. 25, bott.,	...	...	...	...	28·45484 28·45494	·10	28·48700 28·48710	·10	1·027755 1·027758	0·3	1·027756	1·027727 1·027733	0·6	1·027730	2·6
III.	Distilled water,	28·68060 28·68114	·54	28·71316 28·71297	·19	...	...	...	...	...	...	...	...	...	...	...
,,	St. 78, bott.,	...	...	...	...	29·42998 29·42960	·38	29·46315 29·46303	·12	1·026187 1·026173	1·4	1·026180	1·026097 1·026095	0·2	1·026096	8·4
,,	St. 84, bott. h. w.,	...	...	...	...	29·29762 29·29742	·20	29·33103 29·33078	·25	1·021503 1·021496	0·7	1·021499	1·021497 1·021488	0·9	1·021492	0·7
,,	St. 27, 6¾ fath. from bott.,	...	...	...	...	29·46158 29·46165	·07	29·49507 29·49508	·01	1·027287 1·027290	0·3	1·027288	1·027210 1·027210	0·0	1·027210	7·8
,,	St. 93, bott.,	...	...	...	...	29·47924 29·47902	·22	29·51267 29·51244	·23	1·027903 1·027895	0·8	1·027899	1·027823 1·027815	0·8	1·027819	8·0
IV.	Distilled water,	28·99986 28·99945	·41	29·03408 29·03367	·41	...	...	...	...	...	...	...	...	...	...	...
,,	St. 63, bott.,	...	...	...	...	29·81307 29·81314	·07	29·84684 29·84666	·18	1·028049 1·028052	0·3	1·028051	1·027975 1·027970	0·5	1·027972	7·9
,,	St. 84, bott. 10 a.m.	...	...	...	...	29·56869 29·56892	·23	29·60203 29·60259	·56	1·019622 1·019630	0·8	1·019626	1·019544 1·019563	1·9	1·019553	7·3
,,	St. 22, near bott.,	...	...	...	...	29·80452 29·80488	·36	29·83837 29·83873	·36	1·027800 1·027810	1·0	1·027805	1·027755 1·027764	0·9	1·027759	4·6
V.	Distilled water,	28·04700 28·04720	·2	28·08042 28·08062	·20	...	...	...	...	...	...	...	...	...	...	...
,,	St. 84, bott. l. w.,	...	...	...	...	28·56493 28·56494	·01	28·59754 28·59752	·02	1·018464 1·018463	0·1	1·018463	1·018387 1·018386	0·1	1·018386	7·7
,,	St. 58, bott.,	...	...	...	...	28·83185 28·83193	·08	28·86427 28·86435	·08	1·027982 1·027985	0·3	1·027983	1·027908 1·027910	0·2	1·027909	7·4
VII.	Distilled water,	24·45465 24·45484	·19	24·48341 24·48369	·28	...	...	...	...	...	...	...	...	...	...	...
,,	St. 73, ,,	...	...	...	...	25·07995 25·07968	·27	25·10817 25·10810	·07	1·025565 1·025554	1·1	1·025559	1·025512 1·025508	0·4	1·025510	4·9
,,	St. 26, bott.,	...	...	...	...	25·13700 25·13672	·28	25·16527 25·16513	·14	1·027897 1·027886	1·1	1·027891	1·027843 1·027838	0·5	1·027840	5·1
,,	St. 22, 20 fath. from surf.,	...	...	...	...	25·14317 25·14264	·53	25·17172 25·17119	·53	1·028150 1·028128	2·2	1·028139	1·028108 1·028086	2·2	1·028097	4·2
,,	St. 56, bott.,	...	...	...	...	25·14148 25·14157	·09	25·16975 25·16984	·09	1·028081 1·028085	0·4	1·028083	1·028031 1·028035	0·4	1·028033	5·0
VIII.	Distilled water,	23·16097 23·16119	·22	23·18821 23·18843	·22	...	...	...	...	...	...	...	...	...	...	...
,,	St. 69, bott.,	...	...	...	...	23·81308 23·81284	·24	23·83981 23·83981	·00	1·028151 1·028140	1·1	1·028145	1·028095 1·028095	0·0	1·028095	5·0
,,	St. 80, bott.,	...	...	...	...	23·68334 23·68332	·02	23·70991 23·70987	·06	1·022549 1·022548	0·1	1·022548	1·022497 1·022490	0·7	1·022493	5·5
,,	St. 28, surf.,	...	...	...	...	23·76682 23·76689	·07	23·79373 23·79378	·05	1·026153 1·026156	0·3	1·026154	1·026109 1·026111	0·2	1·026110	4·4
,,	St. 28, bott.,	...	...	...	...	23·81231 23·81260	·29	23·83935 23·83964	·29	1·028118 1·028130	1·2	1·028124	1·028076 1·028084	0·8	1·028080	4·4
,,	St. 54, near bott.,	...	...	...	...	23·81245 23·81269	·24	23·83923 23·83967	·44	1·028123 1·028134	1·1	1·028128	1·028070 1·028090	2·0	1·028080	4·8
X.	Distilled water,	23·67799 23·67780	·19	23·70593 23·70574	·19	...	...	...	...	...	...	...	...	...	...	...
,,	St. 65, bott.,	...	...	...	...	24·34667 24·34666	·01	24·37405 24·37390	·15	1·028245 1·028245	0·0	1·028245	1·028070 1·028090	0·8	1·028181	6·4
,,	St. 28, near bott.,	...	...	...	...	24·32073 24·32070	·03	24·34824 24·34819	·05	1·027133 1·027131	0·2	1·027132	1·028185 1·028177	0·1	1·027095	3·7
,,	St. 60, bott., *Vigilant*,	...	...	...	...	24·34459 24·34454	·05	24·37197 24·37219	·22	1·028161 1·028158	0·3	1·028159	1·027096 1·027095	1·5	1·028102	5·7
XII.	Distilled water,	23·39360 23·39384	·24	23·42154 23·42149	·05	...	...	...	...	...	...	...	...	...	...	...
,,	St. 69, surf.,	...	...	...	...	23·94669 23·94609	·60	24·97361 24·97333	·28	1·023638 1·023612	2·6	1·023562	1·028722 1·028700	1·2	1·023566	0·4
,,	St. 84, 4¾ faths.,	...	...	...	...	23·97393 23·97374	·19	24·00084 24·00092	·08	1·024802 1·024794	0·8	1·024798	1·024735 1·024738	0·3	1·024736	6·2
,,	St. 59, bott.,	...	...	...	...	24·05072 24·05065	·07	24·07776 24·07796	·20	1·028085 1·028083	0·2	1·028084	1·028020 1·028028	0·8	1·028024	6·0
,,	St. 90, bott.,	...	...	...	...	24·07638 24·07674	·36	24·10364 24·10400	·36	1·029181 1·029196	1·5	1·029188	1·029124 1·029139	1·5	1·029131	5·7

fore, that I am well within the mark in assuming 0·05 mgr. as the maximum error of any single weighing.

The temperature of the balance-room and the height of the barometer were regularly observed. I made no hygrometric observations, but readings of the wet and dry bulb thermometer, taken within a mile of the balance-room, by Mr Blackwood, were kindly supplied to me. In order that the humidity of the air inside the room might be as nearly as possible the same as that outside, the door and windows were kept open for some time previous to weighing.

I am well aware that the corrections for humidity thus arrived at are but roughly approximate, but I thought it better to derive them in this manner rather than to apply a constant correction.

A very considerable error in the estimated amount of moisture in the air does not affect the result in the fifth decimal place.

From the data thus obtained the density of the air was calculated, and the corresponding corrections applied to all the weighings.

Discussion of Results.

The degree of accuracy to which I have attained by this method will be best seen by an inspection of Table II., in which I have collected all the necessary data. After the above description of the mode of working the table will speak for itself, but a short discussion of the results may be useful.

Sprengel, in a paper describing this form of pyknometer, gives the results obtained with one of them in two sets of three weighings of water at 15° C. and 16° C. respectively, the maximum difference between any two weighings at the same temperature being 0·1 m.gr. Though I have often in individual cases obtained results fully equal to this, I have not been able to attain to this degree of accuracy throughout. Sprengel's weighings being, I suppose, all made within a short time, were not reduced to vacuo; and I at first thought that, as a considerable lapse of time was unavoidable between my weighings, the neglect of this reduction to vacuo might account for the discrepancy. This hope, however, was only very partially fulfilled. No doubt in some cases the improvement was very marked, yet in others the effect of the correction was to increase the differences considerably. If the mean be taken of all the observed differences between the several duplicate weighings, both of distilled water and of the samples of sea water, it will be found to be 0·22 m.gr. as against 0·18 m.gr. in the case of the weighings after reduction to vacuo. The gain over the whole is therefore slight but still unmistakeable; and in view of the very considerable influence of this correction upon individual results, it is evident that it would not be safe to neglect it.

Sprengel points out in his paper a source of error, viz., the inconstancy, even to the extent of 0·1° C., in the temperature of the bath. It is possible that, in spite of the care I took to insure perfect constancy of temperature, that this may have had an appreciable effect, and that a more complicated mechanical arrangement for maintaining constancy of temperature would result in a marked improvement, but I am inclined to doubt this.

A comparison of the results (corrected to vacuo) obtained with the different tubes throws a good deal of light on the question.

					Difference in mgrms.
Tube	I.	. .	Mean of	4	. . 0·38
„	II.	. .	„	3	. . 0·11
„	III.	. .	„	5	. . 0·16
„	IV.	. .	„	4	. . 0·38
„	V.	. .	„	3	. . 0·10
„	VII.	. .	„	5	. . 0·29
„	VIII.	. .	„	6	. . 0·18
„	X.	. .	„	4	. . 0·15
„	XII.	. .	„	5	. . 0·19

Tubes I. and IV. are evidently singled out as being in some way defective. The only points noticeable in those two tubes were, first, that owing to a very slight irregularity at the end of the capillary terminal, the flow of the water on applying the blotting paper was impeded, which made the rapid adujstment of the level of the water in the wider terminal somewhat difficult, and thus increased the time during which it was necessary to keep the tubes out of the melting ice; and, secondly, that in these tubes the bore of the wider terminal was greater than in the other tubes, and, *cæteris paribus*, the effect of the observational error in adjusting the level of the water in the wider terminals of these tubes must have been greater than in the other tubes with wider terminals of narrower bore. These two very slight defects fully account, I believe, for the inferior results obtained with these two tubes, though they were not sufficient to condemn them at the first trials, and before all the results could be compared with each other.

Passing from the consideration of the weighings as such to the specific gravities derived from them, it will be observed that only in two cases out of thirty does the difference between the two corrected specific gravities ${}_0S_0$ reach 2 in the fifth place of decimals, viz., in Tube VII., station 22, 20 fathoms from surface, where the difference in the fifth place is 2·2, and in Tube VIII., station 54 bott., where the difference is 2·0. Even on the lowest assumption, *i.e.*, that the difference in a given case is to be credited to one of the determinations, and not to be regarded as arising from the one result being too high and the other too low; the specific gravity must still be regarded as correct to about 1 in the fifth place of decimals. This is most satisfactory. None of the methods hitherto adopted for hydrographic work can claim an equal accuracy. Moreover, in thus taking an extreme case, we are evidently undervaluing the accuracy of the method.

The only two instances in which the differences reach 2 in the fifth place were not obtained, as might have been expected, with the defective Tubes I. and IV., but with Tubes VII. and VIII. In these two cases the differences between the corrected weights are 0·53 mgr. and 0·44 mgr. respectively,—differences which, even if they be not classed as accidental certainly have a disproportionate influence on the specific gravities, owing to the comparatively small capacity of these particular tubes. If in future work only such tubes as have a capacity of *circa* 30 to 35 c.c. be employed, the effect even of such differences would be very much reduced.

In order to facilitate reference to the annexed chart, I have arranged in Table III. the 'corrected average specific gravities' in order of magnitude under the heading ${}_0S_0$.* The numbers in this column are for the most part the same as those given in the last column but one of Table II. They are strictly comparable with each other without any correction, and are derived directly from my observations. In order to facilitate comparison

* tSt' means specific gravity at t'^0 referred to water at t^0 as = 1000.

TABLE III.

Sample from	Date when Collected.	Depth.	$_0S_0$ Bottom.	$_0S_0$ Surface.	$_4S_0$ Bottom.	$_4S_0$ Surface.	$_4S_{15\cdot56}$ Bottom.	$_4S_{15\cdot56}$ Surface.
St. 84, bott. l. w. 9 p.m.,	Sept. 20, 1883.	...	1018·386	...	1018·263	...	1016·083	...
St. 84, bott. 10 a.m.,	„ 19, „	...	1019·553	...	1019·431	...	1017·251	...
St. 84, bott. half ebb, 5 p.m.,	„ 20, „	$4\frac{3}{4}$ fath. ?	1020·470	...	...	...	...	...
St. 84, bott. h. w. 2.50 a.m.,	„ 21, „	...	1021·492	...	1021·370	...	1019·190	...
St. 80, bott. 4 p.m.,	„ 17, „	$3\frac{1}{2}$ fath.	1022·493	...	1022·371	...	1020·191	...
St. 69, surf. 3.35 p.m.,	„ 14, „	15 „	...	1023·566	...	1023·443	...	1021·263
St. 70, surf.,	„ 14, „	...	...	1023·764	...	1023·641	...	1021·461
St. 31, surf. 11.45 a.m.,	Aug. 21, „	4 „	...	1025·090*	...	...	...	...
St. 73, 3.45 p.m.,	„ 15, „	3 „	...	1025·509	...	1025·386	...	1023·206
St. 71, surf. 3 p.m.,	„ 15, „	...	...	1025·756	...	1025·613	...	1023·433
St. 78, bott.,	„ 17, „	...	1026·096	...	1025·973	...	1023·793	...
St. 28, surf. 9.20 a.m.,	„ 21, „	$4\frac{1}{2}$ „	...	1026·109	...	1025·986	...	1023·806
St. 28, near bott. 9.20 a.m.,	„ 21, „	$4\frac{1}{2}$ „	1027·095	...	1026·972	...	1024·792	...
St. 27, bott. 4.30 p.m.,	„ 20, „	$6\frac{3}{4}$ „	1027·210	...	1027·086	...	1024·906	...
St. 25, bott. 1 p.m.,	„ 20, „	8 „	1027·730	...	1027·587	...	1025·407	...
St. 22, near bott.,	„ 17, „	...	1027·759	...	1027·635	...	1025·455	...
St. 26, bott. 2.30 p.m.,	„ 20, „	12 „	1027·841	...	1027·717	...	1025·537	...
St. 58, bott.,	Sept. 6, „	26 „	1027·909	...	1027·775	...	1025·595	...
St. 63, bott.,	„ 12, „	38 „	1027·972	...	1027·848	...	1025·668	...
St. 59, bott. 10.50 a.m.,	„ 7, „	38 „	1028·024	...	1027·900	...	1025·720	...
St. 56, bott. 3 p.m.,	„ 6, „	23 „	1028·029	...	1027·905	...	1025·725	...
St. 68, bott. 2 p.m.,	„ 14, „	8 „	1028·057*	...	...	...	...	...
St. 54, near bott. 12.15 p.m.,	„ 6, „	23 „	1028·080	...	1027·956	...	1025·776	...
St. 28, bott. 9.20 a.m.,	Aug. 21, „	$4\frac{1}{2}$ „	1028·080	...	1027·956	...	1025·776	...
St. 22, 20 fath. from surf.,	„ 17, „	38 „	1028·095	...	1027·970	...	1025·790	...
St. 69, bott. 3.39 p.m.,	Sept. 14, „	15 „	1028·095	...	1027·971	...	1025·791	...
St. 60, bott. 11.50 a.m.,	„ 7, „	...	1028·102	...	1027·979	...	1025·799	...
St. 21, near bott.,	„ 17, „	40 „	1028·170	...	1028·047	...	1025·867	...
St. 65, bott. 11.40 a.m.,	Sept. 13, „	$22\frac{1}{2}$ „	1028·181	...	1028·057	...	1025·877	...
			* Uncorrected.	* Uncorrected.				

with the results of other observers, I have arranged in parallel columns the corresponding specific gravities ${}_4S_0$ and ${}_4S_{15\cdot56}$. These latter being calculated by means of Dittmar's tables.*

The samples having the lowest specific gravity met with during the Expedition are those taken at station 84, opposite Clachnaharry, at the entrance to the Beauly Basin. Four samples were taken here at different states of the tide, the influence of which is very clearly shown. The specific gravities ${}_0S_0$ ranging from 1018·385 (1016·083 ${}_4S_{15\cdot56}$) at low water to 1021·492 (1019·190) at high water. From this point the gradually increasing salinity as we proceed down the Firth is indicated by the higher specific gravity 1022·493 for station 80, and still more by the specific gravity of the samples of surface water from stations 69 and 70. The much higher numbers for the samples of *bottom* water from station 69, and even of that from station 70, somewhat higher up the firth, seems to give evidence of the advance of the salter water from the Moray Firth beneath, and only very partially mixing with the fresh water finding its way down from the upper reaches. The specific gravities of the samples collected near the mouth of the Spey are also suggestive. At station 28, for instance, the specific gravity (${}_0S_0$) of the bottom water is 1028·08—near bottom 1027·21—and at the surface as low as 1026·109, while the depth at this station was in all only 4½. Several farther points of some interest are suggested by the specific gravities contained in this table, but I postpone any farther discussion for the present, because whatever interest my results may have there are far too few of them to be by themselves of much value.

Ratio of total Halogen to Density.

Great additional light is often obtained by the determination of the chlorine in a sample, as it frequently enables one to avoid erroneous conclusions to which the unsupported specific gravity determinations may seem to point. Dittmar has shown that in ocean water the ratio of the chlorine, or more accurately of the total halogen calculated as chlorine to the density is practically constant, and that, therefore, if the one is known the other may be accurately calculated. This simply results from the fact that one sample of ocean water differs from any other merely by the amount of water in which the constant saline constituents are dissolved. As a general rule no appreciable differences in the relative proportions of the various saline constituents of ocean water are revealed even by the most refined chemical analyses.† The amount of saline matter added, even in a number of years, to the ocean is almost insignificant when compared with the amount already present in it. When we confine our observation, however, to the conditions obtaining in localities near the mouths of rivers, the influence of the saline matters carried down by the river water may become appreciable, and thus, for instance, the ratio of total halogen to density may be altered. In such localities it is not safe to rely on the specific gravity only for an insight into the character of a given sample of water. Mr T. F. Barbour has determined for me the total halogen contained in some of my samples by Dittmar's modification of Vollhard's method, with which he was already familiar, having executed most of the total halogen determinations published in the 'Challenger' reports. Simultaneously with the estimations of the total halogen the specific gravities were redetermined, as the samples, having stood some time, were appreciably altered. The results of these determinations are given in Table IV. Without entering into any detailed discussion of this table, which will be easily understood by any one

* *Challenger Reports,* vol. i.

† The lime varies slightly with the depth.

TABLE IV.

Designation.	${}_0S_0$	${}_4S_0$ as Found.	${}_4S'_0$ as Calculated. from χ.	${}_4S'_0 - {}_4S_0$	D.	Difference from Dittmar's Value for D.	χ as Found.	χ' as Calculated. from ${}_4S_0$.	$\chi' - \chi$.
St. 20, bott., . . .	1028·22	1028·10	1028·10	0·00	1·45947	−0·00046	19·333	19·327	−0·006
St. 21, bott., . . .	1028·26	1028·13	1028·15	+0·02	1·45907	−0·00086	19·363	19·352	−0·011
St. 31, surf., . . .	1025·10	1024·98	1025·00	+0·02	1·45936	−0·00057	17·209	17·191	−0·018
St. 84, bott. { 9 p.m., 20/9/83, low water, }	1018·56	1018·44	1018·46	+0·02	1·45843	−0·00150	12·726	12·713	−0·013
St. 84, bott., 10 a.m., 19/9/83, .	1019·76	1019·64	1019·66	+0·02	1·45841	−0·00152	13·549	13·535	−0·014
St. 84, bott. { 2.50 a.m., 21/9/83, high water, }	1021·60	1021·47	1021·50	+0·03	1·45933	−0·00060	14·806	14·790	−0·016
St. 80, bott., . . .	1022·66	1022·54	1022·57	+0·03	1·45491	−0·00502	15·539	15·521	−0·018
St. 25, bott., . . .	1027·80	1027·67	1027·71	+0·04	1·45775	−0·00218	19·065	19·037	−0·028
St. 65, bott., . . .	1028·29	1028·16	1028·20	+0·04	1·45801	−0·00192	19·399	19·374	−0·025
St. 78, bott., . . .	1026·32	1026·20	1026·25	+0·05	1·45708	−0·00285	18·064	18·028	−0·036
St. 22, 20 fathoms from surface, .	1028·19	1028·06	1028·12	+0·06	1·45699	−0·00294	19·344	19·305	−0·039
St. 68, bott., . . .	1029·12	1029·00	1029·09	+0·09	1·45494	−0·00499	20·010	19·946	−0·064
St. 69, bott., . . .	1028·75	1028·63	1028·73	+0·10	1·45511	−0·00442	19·758	19·693	−0·065
St. 69, surf., . . .	1024·52	1024·40	1024·51	+0·11	1·45283	−0·00710	16·874	16·792	−0·082
St. 73, ...	1026·03	1025·91	1026·08	+0·17	1·45002	−0·00991	17·948	17·826	−0·122
St. 70, surf., . . .	1024·56	1024·44	1024·73	+0·29	1·44288	−0·01705	17·018	16·819	−0·199

familiar with Dittmar's 'Challenger' report, it will readily be seen that the differences between the calculated and observed specific gravities and those between the calculated and observed total halogen indicate differences between certain of the samples, which differences could not be detected by the total halogen determination alone, or by the specific gravities alone.

Thus the samples, station 68 bottom, station 69 bottom, station 69 surface, station 73, station 70 surface, are all characterised by a marked deviation in the ratio between the density and total halogen calculated and found, and *vice versâ*. They are thus grouped together, and a reference to the chart will show that these samples were all collected within a limited area.

On the other hand, the samples collected in the Beauly Basin and in Spey Bay, which show a low specific gravity due to the large admixture of river water, show no such deviation in the said ratio, and are in Table IV. associated with samples collected at stations 20 and 21 well out to sea.

These relations evidently require confirmation and elucidation by further careful investigation, but the suggestion may be hazarded that the great purity of the waters of the Spey and Ness, draining as they do a region of granite and crystalline schists, will account for the non-disturbance of the normal ratio, while the deviation from the normal ratio in the samples specified above may be caused by the water flowing into the Cromarty Firth, with the character of which I am as yet unacquainted.

The Expedition of 1883 itself, and most certainly the physical work accomplished during it, can only be regarded as purely tentative, and preliminary to systematic work on a much larger and more exhaustive plan whenever the indispensable facilities are available. The method described above for the determination of specific gravities in hydrographic work is sufficiently illustrated by the results detailed.

I have every confidence that if applied to an extensive series of samples collected systematically, and as far as possible simultaneously at various points of importance, such as the firths and estuaries of our coasts, the method I have elaborated will yield results of the greatest permanent value both scientific and practical. Systematic temperature and other physical observations should of course accompany the collection of samples.

Further, the determination of the specific gravities of the sample should be, in each case, supplemented by chemical investigation.

Since 1883 the observations carried on in connection with the Scottish Marine Station, and discussed by Dr H. R. Mill * show that the conditions of different river entrances as to salinity and temperature are not the same. In the Firth of Forth, for instance, where the river is small compared to the area of the sea-inlet, the curve representing salinity was found to be constant at all seasons, changing its form slightly only after prolonged rain. From the river the amount of dissolved salt increases at first very rapidly as the sea is approached, then more and more slowly, the salinity of surface and bottom at the same time approaching more and more nearly to the same value. Where, as in the Spey, the river is large and rapid, and there is no sea-inlet, each tide drives in and withdraws a wedge of sea water under the river water, which remains always fresh on the surface, and flows over the surface of the sea in a stream which varies in direction with wind and other conditions, and only freshens the surrounding sea-water superficially. In the Firth of Forth, temperature in summer is highest and in winter lowest in the river, and falls or rises steadily as the sea is approached; in winter the surface water is colder

* See *Proc. Roy. Soc. Edin.*

and in summer warmer than that beneath. The conditions in the loch basins of the Firth of Clyde are quite different, and although they are now being studied, are not yet properly known.

It would be very important to extend similar observations to the other firths, estuaries, and rivers in Scotland, and to supplement them by careful chemical analysis.

APPENDIX F.—No. XIII.

REPORT OF THE ST ANDREWS MARINE LABORATORY, No. III. From 1st April 1885 to 31st December 1885. By Professor M'Intosh, M.D., LL.D., F.R.S., &c. (Plate VIII.).

I. General Remarks.

Period Covered by Report.

The period over which this (the third) report extends is seven months. The first report was made some months before the Marine Laboratory was fitted up, the second four months after it was finished. In future, however, it is probable that the report will cover the usual period, viz., twelve months.

Structural Changes.

The structural improvements since last report have been few, and consist of the opening of an eastern window in the main work-room, so that investigations can be carried on in good light during the warm weather, and without exposure to the glare of the sun; and the fitting-up of shelves and a light bookcase in the same apartment and in the small accessory work-room. A microscopical cabinet and three suitable work-tables have also been procured, so that the laboratory now presents greater conveniences for the workers.

Desiderata.

As mentioned in the last report, an open-air tank of large dimensions would be a useful acquisition in connection with the investigations on the Scotch Fisheries. The introduction of a fresh water-pipe and accessories, a canvas or other shade over the western windows and high-level tank, and the aeration of the tanks by an inexpensive series of aerators, the addition of nozzles with stop-cocks, and the lighting of the laboratory with gas, are also much required. Moreover, the occasional use of a steam-vessel for procuring ova and carrying out other investigations is indispensable. Time would also be largely saved if a more speedy access to the laboratory be obtained instead of the detour at present necessary.

Remarks on Food-Fishes.

Mode of Capture of Food-Fishes by Liners.

The boats leave the harbour at various times, but generally so as to reach the fishing-ground before daylight. Thus in the summer months,

and early autumn, *e.g.*, August, the boats seeking the 26-fathom ground off the Bell Rock would leave the harbour about 11 P.M. These boats carry main and mizzen masts, with foresail and mizzen (ordinary) sails. Each man in the boat (7 in the larger and 5 in the smaller) has eight strings in summer and four in winter, making two entire lines in the former case and one in the latter. Each string has twelve scores of hooks, 44 to 45 inches apart from each other on the line. The lines are carefully baited by the women of the family, and laid most neatly and regularly in the basket, the rows of folds being kept separate by a thin layer of 'bent-grass.' The dexterity of the women in removing the mussels from their shells, in baiting and arranging the lines, is nowhere more remarkable than at St Andrews. It is clear that upon the latter much of the success of the fishing depends. On reaching the fishing-ground, for instance (some miles south-east of the Bell Rock), the flags and buoys are got ready. The flag consists of a tough tapering pole from 10 to 14 feet in length, having at the upper end one or two small black flags (one above the other), a heavy piece of iron pipe at the lower end as a sinker to keep it erect, and a mass of cork near the water-line to float it. One is put overboard, and attached to it is a string, with three or four bladders as floats, fixed to a heavy sinker (30 to 40 lbs.), the free string of the latter being modified according to the depth of the water. To the long line attached to the sinker the first line (from a basket) is joined. The boat meanwhile, in the case of a south-east wind, is kept on a course E. by N.E. (about six points to the wind), under the mainsail only, or more rarely under both sails in light wind, the skipper often at the helm and the senior fisherman ready with his line. As the boat progresses the man pays out the first line in the case mentioned, over the port-side near the stern, in some instances over the 'funnel,' a cylinder of zinc about 2 feet 8 inches in length and 6 inches in diameter, with a rim at one end for the hand in steadying. This simple instrument prevents injury to the hand from the hooks in paying out. Before the first line is exhausted the second is attached, and so on with the series. So carefully are the lines adjusted in the baskets by the women that it is rare that a 'lump' is sent overboard. The older plan in shooting lines is to lift the line with the right or left hand rapidly and pay out over the side of the boat, the fisherman standing with his back to the stern. The wounds from the hooks, however, caused them occasionally to use a stick, such as the shaft of a club, to lift and pay out. Each line has 960 hooks baited with mussels, and it lasts from six to seven years. Two sets are generally in use. Each line costs about £3, and thus they are somewhat cheaper than at Eyemouth, where the cost was stated to be £3, 10s.* The time required for paying out the lines varies from three-quarters of an hour or less to two hours, according to their number and the amount of wind. In the middle of the lines a flag-buoy like that first put out is placed, and to the end of the last line another with its floats and sinker. The boat on concluding the paying out lies-to for half-an-hour or a little more, with sails down. At the end of this period the mainsail is put up, or with a good wind half hoisted, and the buoys, the flag, and sinker are drawn up (bladders are caught with a grapnel, or with a short boat-hook or 'clip,' a kind of gaff), and the lines are hauled in. In the case formerly mentioned (S.E. wind, with the lines shot E.N.E.), the lines are pulled in over the port-side but further forward than whence shot. The side of course varies with the wind. It might be supposed that the lines last shot would have less time for the capture of fishes, but sometimes the best catch occurs on them. In summer the bait is much destroyed by young fishes, so that

* Report of H.M. Trawling Commission, 1885.

many empty hooks come in. As the fishes are drawn over the gunwale they are expertly swung into the further (broad or high) end of the basket, and two other fishermen quickly remove them from the hooks, and either throw them into the boxes or into the hold. In removing the hooks from the fishes considerable laceration occasionally occurs, and in the majority loss of blood to a greater or less extent takes place. Every fish as a rule is alive and vigorous when drawn in, and several jerk themselves from the hooks just before reaching the gunwale. A wary fisherman, however, is generally ready with a landing-net and regains most of them. The external appearance of the fishes is very satisfactory, for being pulled singly through the water the cupreous sheen of most of the haddocks is undimmed, while the cod, whiting, whiting-pout, flat-fishes, and other forms are almost faultless in their several tints, when uninjured by predatory marine forms. The fishes are placed in boxes according to species and size, a box being set apart for odd fishes, such as young cod, whiting-pout, and whiting. No water is allowed to touch the fishes after removal from the lines.

If the lines are shot on hard ground, *i.e.*, on a stony bottom, they sometimes give way, leaving a longer or shorter portion with the hooked fishes at the bottom. The broken line is searched for with a grapnel, and if success attends the efforts the hauling-in is continued up to the last buoy, sinker, and flag. Otherwise the boat is steered for the three latter, which are taken on board, and the lines are drawn up from this end. The hauling of the lines varies in duration according to circumstances, a period of from 20 to 25 minutes being an average space for each line.

When the boats go to the ground in company it is evident that care must be taken to shoot in a direction parallel to that of their neighbours, else the lines might cross, and each might haul up a neighbour's lines with his own, and thus fishes which are the property of others would be brought in tempting proximity. This crossing of the lines might readily happen when the boats have been somewhat early on the ground and are 'lying-to' till daylight approaches. If in such circumstances one boat be started early, and a lantern instead of a flag be placed on the first pole, the nearest fisherman might imagine the light to indicate his neighbour's boat, and proceed by-and-by to shoot his lines right across those already on the bottom.

The black flags used by the liners have been found more useful than white, since they are much more readily detected both against the horizon and the water as it glimmers in the feeble morning light. A lantern on the pole is somewhat heavy, unless special precautions are taken to balance it, and then it is readily fractured, especially in rough weather. A keen eye, however, does not always make out a black flag in the gray morning light, especially if no boat be in sight, or if a slight mist be present.

As soon as the lines are hauled the boat makes for the harbour, the helmsman and the watch taking up their duties, while the other men either rest or go over the lines, removing the mussels, star-fishes, and small fishes, and 'bending' the hooks on the twisted hemp.

Injuries to Baited Hooks and to Fishes on the Lines.

The injuries to food-fishes in the sea after capture off St Andrews are not numerous, though they deserve attention. It is also noteworthy that such lowly organised forms as the ordinary anemones (*Tealia*, &c.) would appear to cause injury when six or eight of them seize on the mussels and hooks, for the strain causes rupture of the line. Their presence on

the hooks, when the line is afterwards pulled up from the end next the flag and buoys, renders such a cause probable.

The first group in zoological order which is a source of annoyance to the line fishermen is that of the star-fishes, and insignificant as such creatures individually may seem, their numbers make them so formidable that on certain grounds off Fife Ness (with the Carr and Balcomie nearly in a line) the fishermen do not care to shoot their lines, since their bait, especially at night, would be seized for the most part by star-fishes. Moreover, if lines have been long down, as for instance for a night or two during a storm, the fishes captured are so injured (the fishermen say 'sucked') by the cross-fishes that some resemble those removed from the stomach of a predatory fish. The remarkable provision whereby the creatures project the mucous membrane of the stomach compensates for more elaborate modes of attack. By the same method they also remove the oysters from their valves, and thus do great damage to oyster-beds. Scarcely a line-basket is brought on shore by the fishermen without a load of star-fishes, which have fastened on the bait in the water. The chief depredator is the common star-fish (*Asterias rubens*), though the habit is common to the group, so that several rare forms, such as the ling-thorns, are thus obtained for museums.

The common edible crab, the shore crab, and a few others, often disfigure fishes on the lines first shot, especially after a storm in the bay. The disturbance of the bottom, according to the fishermen, causes the crabs to 'creep.' There is this in support of the latter notion, that not a few young edible crabs, shore crabs, and others, are always tossed on the west sands after a storm. The injured fishes have the abdomen rudely lacerated and the viscera torn out, and occasionally the smaller forms are severed right across.

Amongst the mollusks one of the chief marauders is the great whelk (*Buccinum undatum*), which is everywhere abundant on the hard ground so frequently chosen by the liners. These shell-fishes attack the hooked fishes so successfully with their rasping tongues that, if undisturbed, only the skin and skeleton remain, though a less injury disfigures the fish. The squids (cuttle-fishes) again are partial to the hooked round fishes, such as the haddock, whiting, and bib, which they generally injure anteriorly by removing the muscles from the dorsum behind the head and in the neighbourhood of the anterior dorsal fin, while their suckers make unsightly patches on the surface of the fish. In many cases the injury caused by the cuttle-fishes is comparatively slight, but in others the brain is exposed, especially in young fishes. It is interesting to find that the cuttle-fishes generally seize on the 'nape' of the neck.

The attacks of the glutinous hag (*Myxine*), the so-called 'eel' of the fishermen, are not much complained of at St Andrews, though hundreds are annually captured by the liners, for they greedily seize on the mussels. It only rarely happens that they enter the mouth or other aperture of a hooked cod and remove all the soft tissues between the skin and the skeleton.

On Two Kinds of Fishing in which many Immature Fishes are Captured.

Two modes of fishing occur to me on the present occasion, as illustrative of the destruction of immature fishes, viz., sprat fishing and shrimp-trawling.

Shrimp-Trawling in the Thames.

This industry—to take an example of the region reached by traversing Canvey Island and trawling towards Tilbury Fort—is carried on by boats about 32 feet in length and 11 in breadth at the widest part, but only 6 feet at the stern. The usual crew consist of two men and a boy. The trawl is about 14 feet in length of beam, and the mesh of the net is small. The trawl-ropes are fixed separately to the side of the boat a little behind the middle, and the direction of the boat is such that the trawl is carried across the current. The trawl is kept down for about two or three hours, and when pulled up, the contents are turned out on deck (near the stern) by loosening the end of the bag. They are lifted by one of the men into a sieve of the regulation size and shaken, and he also passes his hand frequently over them from side to side. The small examples fall on deck, while he picks out the prawns, young fishes, anemones, and other unsaleable animals. He then transfers the sieve to his comrade, or empties it on deck so as to form a heap. The latter (comrade) and the boy pick out the prawns more carefully, and the man taking a measure, places the shrimps in the boiler, which is filled with strong brine, indeed, on Saturday, so strong as to float an egg. The water is very hot, and thus the shrimps are quickly boiled; it is said the more quickly the better. They are then taken out by aid of a ring net with a ¼ inch mesh, and laid on netting to dry, after which they are measured and placed in hampers for the London markets.

An average 'catch' of shrimps during a week is about 150 gallons, the price obtained for which is £3, 2s. Such a sum, it appears, yields the three parties connected with the boat 19s. 7d. per share. Occasionally a single 'catch' yields from 30 to 40 gallons of shrimps, but it is variable.

Amongst the shrimps brought on board by the trawl are great numbers of young food-fishes, such as soles, plaice, dabs, common flounders, young bibs (whiting pout), and whitings, besides father-lashers, unctuous suckers, and other forms. The destruction of young fish-life must be very considerable, unless great care be exercised, since the attacks are so constant. It is true many of the flat fish will survive the attentions of the shrimpers, but it is not always possible to avoid loss.

Sprat-Fishing.

The second kind of fishing is sprat and sparling fishing, both being similar, and a modification of trawling. They are carried on in the estuary of the Tay and various Scottish rivers by yawls or other boats which are fixed by chain and anchor, the bow pointing up stream. The usual length of the beam of the trawl is about 20 feet, and both the top and the bottom of the net are furnished with one. The upper beam is fixed to the bowsprit, and the net is hollowed for the reception of the boat behind the beam. The distance between the upper and the lower beam is usually about 24 feet. From the beams the net, which has the shape of a trawl-net, but of fine cord, stretches backward as a huge pocket of about 90 yards in length. In front the net has meshes of about ¾ inch from knot to knot, while at the posterior or cod-end it is only ¼ inch. This huge apparatus is then so placed that the current sweeps everything into it, and it is sometimes so full that it has to be emptied piecemeal by aid of the small boat.* In former times the sprat-net was only about half the length, and made of much heavier cord, with wider meshes.

* The net, anchor, and trawl-ropes cost about £25. The fitting of a yawl for the work is attended with an expenditure of about £50.

This net is a very destructive one to young fishes; indeed, the quantities caught are often so enormous that lines of railway waggons are sent off for manure. Besides sprats and herrings of various sizes, whiting, young cod, common and sand-eels, many young flat fishes, such as plaice, dabs, common flounders, and other young fishes, are captured. In the unsaleable class are father-lashers (*Cotti*), armed bullheads, fifteen-spined stickle-backs, Montagu's suckers, and other forms. Moreover, it is stated, not a few salmon are caught by this apparatus, besides a large quantity of small shrimps, which are unfit for the market. The tenacity of life in the armed bullheads is considerable, and some of them will bear the voyage shorewards in the Tay, a railway journey to St Andrews thereafter, in the midst of the shrimps, and still survive. In a father-lasher (*Cottus scorpius*) $10\frac{1}{2}$ inches long, the stomach contained no less than 25 sprats, mostly $2\frac{1}{2}$ inches in length, besides the debris of others which could not be readily distinguished. Amongst the small reddish ova in the developing ovaries of this example were a few pale ova having a bulk 4 or 5 times as large as the rest. Whether these were the remnants of last year's ova, which seems unlikely, or a few specially developed, is at present uncertain. Their structure was normal.

Examination of Food Fishes.

Gurnards.—Specimens both of the red and the sapphirine gurnard are procured off the Bay, the latter perhaps being more abundant than the former. They seem chiefly to frequent the mouth of the Forth, and several were forwarded by Mr Scott.

Tunny.—A very fine male tunny (Plate VIII.) was courteously forwarded on the 17th October by Mr Scott on behalf of the General Steam Fishing Company, of Granton, and was dissected at the Laboratory. The huge proportions of this fish made it an interesting subject for comparison with the forms usually observed in Britain. Its whole length was 9 feet, and its weight about $6\frac{3}{4}$ cwts. It was caught in the trawl of the steamer 'Douglas' in the 'Traith,' off Pittenweem, a region formerly famous for its turbot and other flat fishes, and also occasionally for its herrings. The animal was dead when the trawl was drawn up, apparently judging from the abrasions on its surface and fins, having exhausted itself in its desperate struggles to escape. An account of the anatomical and other features of this rare visitant to these shores will be published in a scientific journal,* but the following dimensions, with the accompanying sketch and remarks, will be useful.

Total length, 9 feet.
Greatest girth, 6 feet 5 inches; at base of tail, 11 inches.
Mandible to pectoral, 2 feet 2 inches.
" to margin of gill-cover, 2 feet $3\frac{1}{2}$ inches.
Gape, upper edge, $7\frac{1}{2}$ inches.
" to angle of maxilla, 10 inches.
Width of gape (from premaxillary region to mandible), 8 inches.
Tip of snout to anterior border of first dorsal, 2 feet 6 inches.
" " " second dorsal, 4 feet 5 inches.
" " base of tail, 7 feet 10 iuches.
Length (along base) of first dorsal, 1 foot 11 inches.
" " second dorsal, 9 inches.
Height of first dorsal (base to apex), $10\frac{1}{2}$ inches.
" second dorsal (along the margin) 1 foot, $3\frac{1}{2}$ inches.

* *Ann. Nat. Hist.*, April 1886.

Distance from tip to tip of tail, 2 feet 10 inches.
Ventral fin (base to apex), $10\frac{1}{2}$ inches.
Pectoral fin (base), $4\frac{1}{2}$ inches.
„ (height) 17 inches.
„ expanse at tip, 9 inches.
Anal fin (base to apex) 1 foot 4 inches.
„ (base), $6\frac{1}{2}$ inches.

Diameter of exposed part of eye (conjunctiva), vertical, $2\frac{1}{2}$ inches; horizontal, $2\frac{3}{8}$ inches.

This species is a well-known Mediterranean form, and much esteemed as food. The muscles of the present example were very palatable. In its stomach were 3 haddocks of the size termed 'small,' 2 lemon dabs, and 2 common dabs. The tunny in our seas appears occasionally to follow herrings. Thus, one about the same size as the present specimen was captured in the herring-nets in the Gairloch, nearly opposite Greenock, in July 1831, and is now in Andersonian Museum, Glasgow.* This solitary form from the Forth was evidently of considerable age, and its reproductive organs appeared to be in a degenerate condition. It thus, like the old males of other forms, had probably less interest in social life, and if not driven off by other males, had spontaneously taken to a nomad existence. Most of the figures given by previous authors, including the recent figure by Mr Day, differ so much from each other, and from the accurate outline accompanying this note, that considerable alteration must occur with advancing age, or the artists had not observed with scientific eyes.

It is curious that, on the crustacean parasites of the gills, the little hydroid zoophyte, *Obelia*, flourished in great luxuriance. Several large parasitic monostomes occurred at the commencement of the stomach—almost at the œsophageal border.

Weever (*Greater and Lesser*).—Two species of Weever † have been described by most authors who have treated of the fishes of our own and continental countries, viz., the Greater and the Lesser Weever. So far as previous and present examinations, however, can guide me, I am inclined to think there is a very close relationship between them, and that it is possible that one is only the young stage of the other, and that certain distinctions such as the absence of spines above the orbit in the smaller form, and its great depth in proportion to its length, disappear with age. Moreover, in the adult itself, there is considerable variation; for instance, in the semi-membranous prolongation of the free margin of the operculum. The variation in the pigment is easily explicable on other grounds than those of specific distinction. That the smaller form should be fertile at an early age is not altogether a reliable basis of separation, and we know that considerable modification in outline occurs during the growth of several fishes. Besides, I have not been so fortunate as to secure the young forms of the so-called 'Greater Weever,' while the young of the 'Lesser Weever' have been familiar to me for many years from an inch in length upward.

The smaller form (Lesser Weever) frequents extensive sandy reaches, such as those of the west sands of St Andrews, where it delights to immerse itself in the sand, and is tossed on shore after severe storms at all stages. The larger form (Greater Weever), on the other hand, is found as a rule, especially if well grown, in deeper water. In this, of course, it would only coincide in habit with the larger forms of certain other species of fishes.

* Loudon's *Mag. Nat. Hist.*, vi. p. 529.

† *Trachinus draco*, L., Greater Weever, and *Trachinus vipera*, Cuv. and Val., Lesser Weever.

A perusal of Dr Günther's accurate and careful remarks* on the two forms before mentioned strengthens the doubt above expressed.

The Weevers are well-known to fishermen from the wounds inflicted by their opercular spines. A most interesting account of the structure of the parts, and the result of an experiment with the living form, is given by Prof. Allman.†

Shanny.—The comparative rarity of this fish between tide marks at St Andrews is now remarkable. Formerly numerous fine examples could readily be obtained; now only a few young are occasionally procured. It has been suggested by some fishermen that the boys seek it more eagerly, but some other cause for its rarity is doubtless present. It is not uncommon at several parts along the East Coast, and Mr Sim finds it frequently at Aberdeen.

Cod.—On the whole, this species has been more abundant this year (1885) than last, both in regard to liners and trawlers. The young forms off the Castle and other rocks, however, were less frequently procured than last summer. They seemed to be less numerous.

Haddock.—The young haddocks do not appear to keep company with the young cod, coal-fishes, and pollack off the rocks close inshore. As in the case of the cod there is still a hiatus in their history between the period of leaving the surface (after the embryos escape from the pelagic egg), and their capture as little fishes from 2 to 6 inches in length.

Bib or Whiting-Pout and Poor or Power Cod.—In the standard works on Fishes in our country, and in the literature of fishes generally since the time of Linnæus, two species are described in close proximity, viz., the whiting-pout and the poor or power cod. The latter is described as diminutive in size, seldom exceeding 6 to 7 inches in length, and less deep than the former when of the same length. The barbel on the chin is shorter, and there are minor differences in the length of the fin-rays and in the position of the anal fin.

In the most recent work on British Fishes, viz., that of Mr Francis Day, it would appear that the elaborate descriptions in regard to *eye, teeth, fins, scales, lateral line,* and *colours* are not always so satisfactory as they seem, for they fail to show the relationship existing between the adult and young stages of the same species. The author indeed observes under the head of the poor cod: 'Winther places *G. luscus* as a variety of this fish, 'but *G. minutus* is not nearly so deep in the body, while its vent is placed 'below the last rays of the first dorsal fin, and the free portion of its tail 'is more extended. I have not had the opportunity of investigating both 'sexes of these two species of fish.' This remark indicates some uncertainty on the subject, and my own experience of the species has now led me to conclude that what has been described as the poor or power cod (*Gadus minutus*) by several authors is only the young of the bib. Considerable change occurs in the outline of the fins and in the increase of pigment as the adult condition is reached, but a large series from various parts of the British seas gives little doubt as to the identity of the two forms.

It would appear that the confusion in regard to the two species has partly arisen from an examination of preserved specimens. This is probably one of the reasons why they are separated in Dr Günther's valuable and laborious catalogue of the Fishes in the British Museum.‡

It is remarkable that very few males of this fish were procured last season, and this out of a large number of examples.

* *Catalogue of Fishes* (Brit. Mus.), II., pp. 233 and 236 (1860).
† *Ann. Nat. Hist.*, vol. vi., pp. 161–165 (1841).
‡ Vol. iv., pp. 335 and 336 (1882).

Coal-fish (*Green Cod*).—Adults of this species are not unfrequently stranded at all seasons, both on the sands and amongst the rocks. So far as observed, many of these appear to be in perfect health, so that they may have beached themselves while in the eager pursuit of shore fishes. In a few cases the occurrence of green sea-weeds and other peculiar materials in their stomachs would indicate indiscriminate voracity or a morbid appetite. They are very fond of young herrings and sand-eels, and occasionally may be seen off the east sands darting after both with great activity. The habits of this fish are very different from those of the cod.

Pollack.—While the young are frequently found amongst the shoals of coal-fish and whitings in the harbour, the adult is very rarely captured in this neighbourhood. They appear for the most part to escape both the liners and the trawlers.

Ling.—Many young ling of various sizes are caught by the liners. The change which ensues in this species, subsequent to the stage mentioned in last report, may be indicated by the description of one $7\frac{3}{4}$ inches long. Instead of being striped the fish is now boldly and irregularly blotched, both dorsally and laterally, the region of the white stripe being indicated by the pale and somewhat scalloped area dividing the lateral from the dorsal blotches. Fourteen or fifteen of the brownish blotches occur between the pectorals and the base of the tail. They are separated by the whitish areas, which thus assume a reticulated appearance over the anterior dorsal and lateral regions, and both kinds of pigment invade the dorsal fins. The original dark greenish band is more or less evident from the tip of the snout to the posterior part of operculum, but thereafter it is lost. It is less distinct in front of than behind the eyes. The tail has a pale border, with a dark brownish belt of considerable breadth, and a few black touches in it. A broad white streak exists in the upper half within this, but is feebly marked inferiorly. The black pigment is largely developed in the brownish belt along the inferior margin. The black spots at the posterior part of the first and second dorsals are very distinct, and the dark belt of the anal is densest at the posterior end. This specimen came from the neighbourhood of the Carr Rock, but similar examples are generally to be found off the mouth of the harbour at St Andrews. Many of the young Gadidæ thus seem to frequent shallow water at a certain stage of development, the larger examples as a rule seeking the deeper water.

Sand Eel.—The adults have been examined at various seasons, but the ripe forms have hitherto escaped capture.

Halibut.—Two young specimens, apparently about the same age, were caught by a local trawler on the usual ground in the Bay on November 13th. The larger measured 12 inches in length, with a breadth of $3\frac{3}{4}$ inches across its widest part. The general colour was dark olive, marbled with darker touches, which also occurred in the marginal fins (dorsal and anal), the latter presenting lighter basal regions. Moreover, the entire dorsum was dotted with small reddish spots, like those in certain plaice. The stomach of the larger contained, besides a few thread-worms, a young long-rough dab, and a few small shrimps, only the latter occurring in the stomach of the smaller. It is seldom a halibut over 10 or 12 lbs. is caught in St Andrews Bay, the larger examples being found by the liners in deep water.

Salmon.—The great number of salmon caught this season in the stake-nets off the east rocks, ranging from 1 to 4 miles from the east sands, is remarkable. During one week about 500 salmon were obtained. One net was placed opposite the Maiden Rock, a second off Kinkell Ness, and a third off the Black Rock at Kittock's Den.

Common Trout.—A number of yearling brook-trout were placed in the Kinness Burn in spring, the fatty fin in many having first been removed, in order to distinguish them. In June a specimen was obtained in the harbour amongst the Fuci. It had probably migrated to the tidal region to feed on the small crustaceans so abundant there.

Herring.—The young herrings mentioned in last report as having been acclimatised to live in fresh water, still survive, though they have grown very little. Several were lost by leaping out of the vessel and falling into a sea-water tank. Immersion in the salt water was speedily fatal. These captive specimens fed only on earth worms. There is thus a basis for experimenting on a larger scale in regard to the maintenance of these fishes in lakes, as well as their conveyance to distant regions.

Sprat.—Many sprats are caught in the harbour. The great waste of this species which annually takes place in the Forth, Tay, and other rivers, is one of the clamant points in modern fishery legislation.

Conger.—The rarity of the capture of this fish in the neighbourhood during the year is noteworthy. In former days the long line fishermen considered it unsaleable. Accordingly when it reached the gunwale, the head was cut off by a cleaver for the extraction of the hook, and the body allowed to sink.

Ballan Wrasse.—A fine example, 19 inches in length, was captured off Barbet Ness, about five miles from St Andrews, and, as usual, off a rocky shore. The reproductive apparatus (male) seemed to be in an atrophied condition, forming hard fusiform processes, $3\frac{3}{4}$ to 4 inches long. The comparatively small stomach contained chitons, hermit-crabs, fragments of a small sea-urchin, and sea acorns.

Shagreen Ray.—A remarkable monstrosity of this species was procured for the museum from Scarborough fishmarket. At first sight the animal appeared to have two snouts, a second long conical process jutting out on the right, and bearing the great lateral prickles of the region.

Piked Dog-fish.—A large example or two were caught by the liners, and a young specimen lived in the tanks for some time. It is upwards of a year since a large number were captured, viz., in July 1884, when two line boats brought about 100 each from the ground off St Abb's Head.

Porbeagle Shark.—This species is occasionally secured in the salmon-nets. On the 7th of October a male, 7 feet in length, and which had been actively engaged off the mouth of the Forth abstracting the hooked fishes from the lines, entangled itself in the latter, and was captured. In its stomach were four whitings and a haddock partially digested, and two of the former still had hooks in their mouths—a few inches of the 'string' hanging outwards. A few loose hooks also occurred in the stomach. The total length of the digestive canal in a specimen of this size is less than 4 feet, of which the large intestine occupies 16 inches. The two lamelliform lobes of the liver weighed 11 pounds 3 ounces. It is interesting that a former example of the same length was also caught in October.

Recent Additions to the British Fishes.

In the Second Annual Report of the Board a note and figure of a new British fish (*Lumpenus*) was given. A single small example has since been procured by Mr G. Sim of Aberdeen from a local trawler. It is worthy of note also that another rare form, viz., *Gadiculus argenteus*, was procured by Mr Sim. The latter species was first dredged in the Porcupine off the cost of Ireland.

The following structural note is by Professor Cleland :—

On the Structure of the Tail in Myxine (Glutinous Hag). By Professor Cleland, M.D., LL.D., F.R.S., University of Glasgow.

In making a maceration of a specimen of *Myxine glutinosa*, one of a number which I owe to the kindness of Professor M'Intosh, I had the satisfaction of laying bare a remarkable structure in the tail, which appears to have hitherto escaped notice, viz., a triangular plate of cartilage, about half an inch in length, placed beneath the end of the sheath of the notochord. The fore end of the plate is about an eighth of an inch in depth, and at its lower end supports a small bifricating process ending quickly in two minute dilatations which abut against the hindermost pair of mucous glands. The inferior margin is prolonged into about twenty-four longer or shorter rays or processes. These extend a certain distance into the inferior fin-rays of the tail, which otherwise are quite similar to the superior rays, consisting of mere fibrous bands.

Having reference to the disputed position of the Cyclostomata, it appears to me that the structure of the brain, long ago studied by Johannes Müller, can leave no doubt, when taken into consideration with other characters, of their affinity to the Elasmobranchs. I am inclined, therefore, to consider the plates of cartilage in connection with dorsal fins, as in the case of *Acanthias*, developments throwing light on this inferior plate; and, further, to see in this structure the inferior lobe of the heterocercal tails of the sharks, and the infra-cordal portion of the tails of osseous fishes.

When we study the tail of a perch or a salmon we find that although the apparently homocercal form of its adult condition is in reality heterocercal, the notochord having been directed toward its upper edge, yet, in an embryonic condition, the notochord passes straight back, and is surrounded, with supero-inferior symmetry, by a cutaneous fin exhibiting delicate fibrous rays. This resembles the apparent condition of the tail of Myxine; but the cartilaginous plate now described may be regarded as showing a tendency to the second stage of tail-development, in which the inferior lobe exhibits special growth.

On the Eggs and Young of Food and Other Fishes.

The observations on the development of the Food Fishes—just commenced at the date of the last report—were carried on chiefly by Mr Edward E. Prince, up to the second week in September, and a large amount of material has been accumulated on the subject. A preliminary report of his able and beautifully illustrated researches was communicated to the meeting of the British Association at Aberdeen * (Section D. Biology). The labour involved in such a task, especially in regard to the manipulations of the microscopic slides of eggs and embryo-fishes, makes the preparation of the complete results with drawings a comparatively slow process. We hope, however, to be able to communicate these researches to one of the societies before long.

Detailed study of the following species, with pelagic eggs, has been made:—

Cod,	emerged from the egg on	the	9th	day, lived till	the	17th day.
Haddock—1st series	„	„	20th	„	„	27th „
„ 2d series	„	„	10th			
Whiting „	„	„	10th			
Grey Gurnard—1st series	„	„	13th	„	„	24th „
„ 2nd series	„	„	6th			
Common Dab—1st series	„	„	13th	„	„	24th „
„ 2d series	„	„	7th			
Common Flounder	„	„	11th	„	„	24th „
Rockling (5-bearded)	„	„	7th			

* *Vide* 'Report of the Brit. Associat. Aberdeen, 1885.' Section D.

Amongst other forms examined with more or less attention were the following:—

Lump-Sucker.—The adults were obtained both from the rocky borders and from the local trawlers, and the masses of the eggs, which abound in the spring months on the beach and among the rocks were developed in the laboratory. This, however, was by no means an easy task if the eggs had been newly deposited, since the imperfect aeration of the water in the crevices of the intricate masses caused putrifaction in many cases. Successful hatching was more readily accomplished if the eggs were procured in an advanced condition.

Pennant's observation as to the power of adhesion of this species was repeated, and found to be accurate. No difficulty was experienced in raising a pail of water, to the bottom of which the fish was adherent, by grasping the animal by the tail.

Short-Spined Cottus.—The eggs of this species were also somewhat difficult to develop in the tanks, the length of time required in the process likewise giving an opportunity for the decay of certain eggs and the poisoning of the water. The young were more easily procured by obtaining advanced ova from the beach.

Montagu's Sucker.—The eggs of this fish were described and figured in the 'Annals of Natural History,' as well as mentioned in the last Report. They were frequently obtained from the local trawlers during the spring and summer.

Fifteen-Spined Stickleback.—The nests of this species are not uncommon in the rock-pools near high-water mark, and are easily kept in the laboratory. The development of this fish formed the subject of a special investigation by Mr Prince, and a preliminary report was presented to Section D, at the meeting of the British Association at Aberdeen. A more detailed account, with figures, has also appeared in the 'Annals of Natural History.'*

Three-Spined Stickleback.—Very young examples of this common species were examined for comparison with other forms.

Bib.—During the early summer numerous ripe females were obtained, and the pelagic nature of the ova demonstrated, but no males appeared. This species has a spawning-period which extends over a considerable interval.

Ling.—The eggs of the ling were procured in a ripe condition in May, but unfortunately none of the specimens were healthy.

Common Eel.—Ripe eggs of this form were found by Mr Prince in June, and he thought they resembled pelagic forms.

Skulpin and Floating Eggs. — The ova were found to reach maturity in July and August. The pelagic eggs are small, resembling in this respect those of the common dab, and have the investing coat beautifully reticulated. An account of the ova was communicated to the Meeting of the British Association† at Aberdeen, and published in the 'Annals of Natural History.'‡ The variations that exist in connection with the habits of fishes producing pelagic eggs are interesting. Thus, the flat-fishes (*Pleuronectidæ*), which haunt the bottom universally, so far as known, produce floating eggs, while the skates and rays, also frequenting the bottom, have massive eggs that are deposited on the bottom, and are protected by a tough leathery investment. Montagu's sucker—the Armed Bullhead, the Cat-fish,§ and the Skulpin—are likewise examples

* *Ann. Nat. Hist.*, Dec. 1885. † Section D. Sept. 1885.

‡ *Ann. Nat. Hist.*, Dec. 1885, p. 480.

§ Mr Brook includes this species amongst those with floating eggs (*vide* 'The Spawning Period of the British Food Fishes, Fishery Board for Scotland). So far as I have seen the massive thick-walled egg sinks.

of fishes frequenting the bottom; yet the three former have ova with a somewhat thick investment, while the latter has pelagic eggs. In the same way the pelagic herring has ova which are fixed to the bottom, while the equally pelagic coal-fish has ova which float. Again, the rockling, which frequently occurs between tidemarks, has pelagic eggs, while the father-lasher (*Cottus*) has thick-shelled eggs deposited on the bottom. Habit, therefore, has little relationship with the differences in this respect, which seem rather to depend on phylogenetic causes.

Yarrell's Blenny.—Nothing is said about the breeding of this fish in recent works. A female in August (18th) presented small ovaries with only traces of ova; while in another, on 29th November, the ovaries were considerably enlarged, so that the ova were readily distinguished by the naked eye. In all probability, therefore, this species spawns early in the year.

Gunnel.—Day ('British Fishes') observes, 'Nilsson states its spawn 'to be deposited in November. Mr Peach, however, in June believed he 'discovered the spawn of this fish at Fowey, in Cornwall.' From the state of the reproductive organs in August the spawning period would seem to be distant, yet no signs of maturation had been observed in those examined earlier in the year.

Cat-fish.—Some rather small examples of this species have been procured. Thus, on 11th July a specimen, $6\frac{3}{8}$ in., 5th August another, $7\frac{3}{8}$, and on the 27th of the same month, a third, $8\frac{1}{4}$ in., were obtained. A fourth (18 inches in length), now living in the tanks, was procured by the liners. All were captured by the latter on hard ground between the Island of May and the Fife shore.

Viviparous Blenny.—In July the ovary of this fish presents a somewhat spindle-shaped aspect, the greatest diameter in a specimen about 10 inches in length being one-third of an inch. The ova are of a straw-yellow colour, and are attached to the wall by a pedicle. They show a coarsely globular yolk with germinal area and spot, so that they do not appear to be impregnated. Many of these ova are nearly equal in size, and they are surrounded by a vascular investment presenting beautifully reticulated vessels. Until the ovum, therefore, reaches a certain stage of development the access of the spermatozoa cannot take place.

At this season the males have the testes much enlarged, and the sperm-cells contain numerous sperms, and some of the latter even occur around the external aperture. In November, on the other hand, these testes diminish greatly, while the ovary of the female is filled with young progeny. The fluid in the ovary containing advanced young is nearly translucent in the uninjured fish; but shows under the microscope various blood-corpuscles in a degenerating condition, the ovoid form being altered, and their bulk considerably diminished, besides many granules.

Tope.—A fine female example (4 ft. 8 in. long, with a girth of $21\frac{1}{2}$ in., and expanse of tail $11\frac{1}{4}$ in.) was captured in the salmon-nets on the 22nd of August, but unfortunately the viscera had been so crushed that they were almost useless anatomically. The ovaries presented many small ova, some reaching $\frac{1}{8}$th of an inch in diameter. The stomach of the specimen contained a considerable number of herrings.

Thornback.—Our present knowledge of the breeding of this species is comprised in the following remarks *:—'Begins to germinate in June, and 'brings forth its young in July and August (Pennant). Egg deposited in 'May and June (Couch).' Mr Day also quotes Couch's opinion that one of the causes of the diminution of the species is tearing up of the ground by the beam-trawl, so as to destroy the shelter necessary for the perfection of

* Day, *British Fishes*, ii. p. 345.

the eggs. Although I have trawled a good deal both in the shore water amidst the haunts of this species, as well as in the deeper parts of St Andrews Bay, not a single example of the Thornback's purse with either eggs or embryo in its interior has been captured. Moreover, no further shelter seems to be necessary for the perfection of the egg than a friendly reach of shifting sand, on and even occasionally in which egg, embryo, and adult find all that is necessary for their welfare. A few days after the late severe storm (29th Nov.) a large number of the egg-cases of this species was found on the west sands. The fresh purses (containing living embryos) are easily recognised, as a rule, by their olive colour and greater elasticity, as compared with the blackish empty forms. The interior of the fresh capsule presents a smooth glistening whitish coat, enclosing the translucent gelatinous albuminous fluid. The embryo does not appear to be inconvenienced to any serious extent, though a considerable quantity of sand gains admittance. These 'purses' form a most effecient protection to the embryos on the ground selected for their deposition, which, of course, is that frequented by the adult.

On the Habits of Young Food Fishes.—Young food fishes are numerous in inshore water, though, as formerly shown,* the young of both round and flat fishes are found in deep water. Thus a considerable proportion (about nine-tenths) of the total number of immature fishes caught during the investigations, consisting of common and long rough dabs, were procured at some distance from land and in deep water. As a rule, however, many young fishes, such as the cod, coal-fish, whiting, and pollack, are found close inshore, probably because they find their food more readily accessible, and their freedom from attack greater. The same habit is characteristic of the young flounders, dabs, plaice, and turbot, the very young of several of these in their transparent stages being caught at the margin of the rocks or in pools on the sands. It is evident, however, that from some cause or other the larger plaice, turbot, halibut, and ling, generally take to deep water. Indeed, in a shallow bay like that of St Andrews it not infrequently happens that the large plaice found close inshore are sickly or blind. It is known that the young cod, whitings, green cod, and pollack make for the deeper water in their later stages, and it is possible that a similar tendency exists in the large flat fishes, especially such as the halibut and turbot. The constant presence of young ling off the beacon rocks near the pier is another example of the tendency above noted.

This year (1885) very young cod have been less numerous off the tidal rocks than last year; it may be from the prevalence of cold east winds in summer and autumn. On the other hand, those of a larger size (8–18 inches) have been more plentiful than usual, and the same may be said of the young green cod (coal-fish) of the same dimensions.

Diseases of Fishes.

Further Remarks on the Multiple Tumours of Common Flounders, &c.

These tumours have been met with during the season in common flounders and plaice. It was stated last year that when cut into in the fresh state (in a plaice) no cells were visible in the whitish creamy fluid which exudes. It is possible, however, that this depends on the condition of the specimen in regard to the stage of the disease. In a large tumour projecting from the mouth of a common flounder, a section presented the usual miliolar appearance, and the fluid scraped from the cut surface showed masses of

* *Vide* Report on Trawling by H.M. Commissioners, 1885, p. 356. table iii.

small granular cells with distinct nuclei, these apparently being external to the encysted masses forming the tumour, for the contents of the cysts were mainly granular. On the other hand, a section of a tumour lying beneath the skin of the coloured surface near the tail, and containing a softened surface which, to the naked eye, resembled tubercle, the structure was mostly granular, with occasional large and small granular cells and fatty globules. In this tumour two bodies occurred in conjunction, apparently immature examples of *Diplozoon paradoxum.* Traces of cysts or capsules were also present, as if the tumour originally had been of the ordinary miliolar character.

In the same example a deep scar, covered with skin, existed at the base of the dorsal fin, about 2 inches from the caudal rays. This appeared to be the cicatrix formed by recovery from a similar affection, which had caused the loss of the tips of the neural spines at the part.

Amongst other diseases noted are a large cystic tumour of the head of a cod, and the frequent occurrence of various affections amongst the adult coal-fishes. In the tanks the rocklings are subject to many abrasions, which resemble superficial ulcerations. In the dead examples these surfaces are covered with bacteria, but in the living only small hooked parasites were found.

The fungus disease (*Saprolegnia ferax*) of the salmon occurred on a Grayling captured in the Tay.

The Effect of Storms on the Marine Fauna.

Certain forms of marine animals escape capture under ordinary circumstances, either by dredge or trawl, and the most patient search by those who have come long distances to study them has often been baffled. Thus the common spoon-worm, has been searched for in vain by the dredge for many years, and no greater success has followed a careful scrutiny at extreme low water and between tide-marks. Yet a single storm, such as that which recently happened in November, tossed on the east and west sands of St Andrews hundreds of examples in perfect condition, just as they were found nearly half a century ago on these sands by the late Professor Edward Forbes. This may be taken, then, as an example of the effects of special wave-currents on the bottom-fauna.

The great storms affect, directly and injuriously, the fish-fauna of the bay to a comparatively slight extent. A few green cod (saithe), haddocks, young whiting, gunnels, Yarrell's blennies, sand-eels of various sizes, small weevers, common flounders (the emaciated adults occasionally suffering from the multiple tumours), and plaice are stranded, the most abundant species, however, being the armed bullheads (*Agonus*), which, along with other denizens of the sand, have been dislodged and swept shorewards. The purses containing the young skate likewise suffer to a certain extent, but free examples of any size are seldom or never seen. Their intelligence, activity and tenacity of life enable them to surmount such difficulties.

The effect on invertebrate life is more distinct, and such storms must act as periodic checks, of a character more pronounced than anything due to man's influence. The beach is strewn with masses of various kinds of sponges, in the crevices of which many of the higher forms (*e.g.*, sea-slugs) lurk; and miniature forests of zoophytes cover the tangles, are scattered freely as arborescent tufts, or rolled into felted balls by the action of the surf. Fine examples of an anemone (*Peachia*) living freely amongst the sand are mingled with the large common forms and the rare *Cerianthus*

and *Edwardsia.* The agitation of the bottom has proved fatal to myriads of sand-stars, which, though forming a favourite diet of most food fishes (and no less of the gulls), are seldom disturbed by a trawl. Multitudes of the common cross-fish, butthorns, sun-stars, common and heart urchins, and here and there a sea-cucumber, are cushioned on the extensive beds formed by the empty tubes of the sand worms (*Terebellæ*), and other debris. Many living specimens likewise occur in the latter tubes, though it is only in very severe agitation of the bottom, with an alteration of the sand-level, that these deeply seated forms are swept on the beach. The most conspicuous amongst the other annelids are the large sea mice, which occasionally are heaped in long lines to perish on the sand. The crabs include small specimens of swimming crabs (but this year not one variegated swimmer), numerous masked crabs (chiefly males), and hermit-crabs.

The shell-fishes which have been dislodged are very abundant, and two of these especially merit notice, both from their immunity in regard to capture by either dredge or trawl, and their value to the fisherman as bait. They are the *Cyprina* (the 'daikie' of the fisherman), and the razor-fish, both burrowing deeply in the sand. Most of the mollusks which inhabit the extensive sandy flats of the bay are represented, such as *Mya, Mactra, Venus, Tellina, Donax, Natica,* and *Scaphander*; while *Buccinum* and *Fusus,* frequenting different ground, also largely suffer.

Remarks on Invertebrates, including forms used as Bait.

The recent storm in November was noteworthy for the number of fine examples of the anemone, *Peachia hastata*, dislodged from the sand. It was discovered for the first time in Britain (in 1846) by the late Professor John Reid and Mrs Macdonald, of St Andrews, after a similar storm, but the former author gave no name, and his figure was indifferent.* Three years afterwards it was fully described by Mr Gosse,† and is now adequately figured.‡ In confinement it is by no means hardy if care be not taken to supply it with sand.

The period of spawning of *Asterias rubens* (the common cross-fish), and *Cribrella oculata* ranges from December to March. Occasionally they are somewhat earlier. A similar relationship of the sexes exists at the breeding season, as in *Antedon* and *Asterina.* The common sea-cucumber deposited a large quantity of reddish ova in April. These were ejected in the form of fragile strings on the surface of the water, the least interference causing them to break asunder and float freely on the surface. The eggs are ovate or somewhat rounded, presenting externally a peculiar villous aspect, apparently from protoplasmic filaments outside the very thin capsule. Unfortunately no male could be obtained. An example of the somewhat rare holothurian *Psolus phantapus*, which for a considerable time has been in confinement, has quite changed its colour. When captured it had the usual madder-brownish appearance, but now it is uniformly dull whitish. Instead of having the five rows of suckers along the cucumber-like body, this form has only three rows confined to a limited area on the lower surface.

Amongst annelids some attention has been given by Mr Prince and

* *Anat. and Pathol. Observat.*, p. 656 (Plate v. fig. 21).

† *Proceed. Lin. Soc.*, March, 1855, and also *Brit. Anem.*, p. 235 (Plate viii. fig. 3).

‡ *Op. cit.*, and also *Marine Invertebrates and Fishes of St Andrews* (Plate ii. figs. 5, 6, and 7).

myself to the reproduction of the lobworm, a species which is extensively used as bait during the warmer months (April to August) for the capture of the ordinary food fishes. It is stated (although this requires confirmation) to live longer on the hook than the mussels at this season, and what perhaps is a more decided point, is that the swarms of young fish do not so readily remove it from the hook before the latter is seized by a marketable fish. Under such circumstances the hook is ordinarily deprived of its covering of bait before it reaches the bottom. The remarkable spoonworm (one of the gephyreans), first found in this country on the west sands of St Andrews, by Professor Edward Forbes in 1840, was procured in large numbers during the storm in November, as on similar occasions in former years, and living examples were forwarded to Professor Ray Lankester, who is specially interested in the group. A somewhat unusual inhabitant of waterlogged and softened wood was the little boring annelid *Polydora.* This wood was of no commercial value; indeed this form has not hitherto been found attacking wood of the slightest economical importance. A skate leech (*Pontobdella*) deposited several eggs in the tank in December, and I have observed clusters of the eggs inside the whorls of the great whelks tossed on the west sands in October.

Amongst the crustaceans examined have been a Norway lobster with ova in October, a common lobster also with ova, and various examples of the smaller species. A very large common lobster caught by a hook is at present in the tanks. Complaints have been made by the local fishermen that their boats are seriously injured by a boring 'worm' when in Zetlandic waters at the herring fishing. Specimens of the wood thus affected have not yet been brought to the Laboratory, but in all probability the damage to the planks has been caused by the little burrowing crustacean (a sessile-eyed form), *Limnoria*, sometimes called the 'Gribble,' so well known as a source of trouble and danger during the works at the Bell Rock, of constant inroads in the wood at Devonport, and indeed all round our shores. The men state, however, that their boats are only attacked off Shetland, never at St Andrews.

In the group of the shell-fishes, the young of *Natica catena* have been developed from the eggs which are deposited in ribbons of a single coil off the west sands, and are frequently thrown on shore. Professor Ray Lankester has also worked at the anatomy of the adult, and he and Mr A. G. Bourne have also examined Chiton. Living examples of the Hungarian cap-shell are at present under observation. The eggs of *Mya arenaria, Cardium, Anomia, Pectunculus, Donax, Scrobicularia, Pecten, Astarte*, and others have also been examined by Mr Wilson. The reproductive organs in *Botyllus* and in the rare *Pelonaia* have also been examined by the same gentleman, who furnishes a special report on the reproduction of the common mussel and allied forms. The ova had to be artificially hatched and studied under many difficulties, and I cannot too highly commend the skill, patience, and perseverance of Mr Wilson in conducting this inquiry. It is of the utmost importance, as the first step towards improving and extending the cultivation of this valuable shellfish, to exhaust its development and life history. Mr Wilson furnishes the remarks which follow this chapter.

The shell-fishes especially interesting as bait are, besides the common mussel, *Mya arenaria, Mactra solida, Cyprina*, and the razor-fishes. These are gathered by the fishermen on the west sands after storms. The large cockle (*Cardium echinatum*), on the other hand, is avoided, as of less value. In February and March the limpets are collected for bait by women who come from Auchmithie, but the local fishermen do not use

them; yet the limpet forms a tough bait, which clings to the hook like a button.

Besides the special work just mentioned, many observations on the phosphorescence of marine animals were made during the summer. These formed the basis of the Address to the Biological Section of the British Association * at Aberdeen.

APPENDIX F.—No. XIV.

REPORT ON THE DEVELOPMENT OF THE COMMON MUSSEL. By John Wilson, Demonstrator of Zoology, University of St Andrews.

The literature of a strictly zoological character dealing with the common mussel, as compared with that bearing on its relative the oyster, is scanty. Especially is this the case in the field of embryology. To affirm that the oyster has been the subject of much exhaustive study, one need only refer to the superb memoirs on the development of the American oyster by Mr Brooks,† and on the development of the European oyster by Drs Hoek and Horst.‡ Such works are patterns worthy of imitation by those who propose to conduct thorough investigations into the life-history of mollusks, the multiplication and preservation of which it is of moment to encourage.

In 1856 Lacaze-Duthiers § gave an account of the development of the gills of the common mussel, having studied forms one-fourth of a millimetre in diameter. At this stage the gills appear, through the transparent valves of the shell, as four separate, thickly-ciliated, club-shaped processes. In the course of development those processes become more and more numerous and coalesce, resulting in the familiar leaf-like gill of the adult. Of the two lamellæ constituting the fully-formed gill, the inner one precedes the outer in development. In 1877 Sabatier ‖ published an elaborate memoir on the anatomy of the adult mussel. The reproductive organs, however, are but slightly touched on. Little attention seems to have been given to the method and time of development of the generative elements until 1884, when Professor M'Intosh, while conducting the scientific investigations on behalf of Her Majesty's Trawling Commission, studied these points. In the published account ¶ of his observations thereon he mentions the perfectly diœcious condition of the species, and gives interesting details of experiments with spermatozoa, evidencing their great tenacity of life after removal from the mussel. By examining mussels at intervals from January to July, he found that in a sexually-ripe, 'as compared with an undeveloped specimen, the mantle in January 'is considerably thicker. A male, measuring 3½ inches in length, pre-'sented in the thickened generative region of the mantle large, pale, round, 'sperm-sacs, filled with minute spermatozoa, which have ovoid bodies 'with finely filamentous tails. The females had the same region of the 'mantle crowded with a prodigious number of minute ova. As the month

* *Vide* Report of the Association at Aberdeen, 1885, Section D (Biology).

† Report of the Commissioners of Fisheries of Maryland, 1880.

‡ *Verslag Oesteronderzoekingen*, Leiden, 1883–84.

§ *An. Sc. Nat.*, ser. iv. tom. v.

‖ *An. Sc. Nat.*, ser. vi. tom. v.

¶ *An. Nat. Hist.*, Feb. 1885.

'(February) advanced, the mantle, especially in the neighbourhood of the 'organ of Bojanus, increased considerably in thickness, so that the region 'hung downward like a pouch or flap on opening the valves. The whole 'surface of the mantle becomes speckled in both sexes with the reproduc-'tive elements. On puncturing the enlarged region of the organ of 'Bojanus in a male on the 17th February, a milky fluid composed of 'sperms exuded. The mantle in this case had increased in thickness about '$\frac{3}{8}$ of an inch, and the development of the sperm-sacs seemed to proceed 'from the dorsal to the ventral edge of the mantle.' Professor M'Intosh found that in general the mussels reached full reproductive maturity in April; thereafter the ova and spermatozoa gradually disappeared from the mantle, until in July those he examined were spent. In July and August he noticed that the surface of St Andrews Bay 'swarmed with minute 'mussels of a somewhat circular outline,' and 'they were much younger 'than the forms procured by Lacaze-Duthiers in the Mediterranean, as they 'were settling on the blades and similar structures within tide marks, 'and which showed four branchial processes behind the foot.' The above is a brief *résumé* of the literature of the special subject in hand. There is an immense amount of published information relating to mussel-culture, such as statistical accounts of the number of mussels sold or used for bait, discourses on the comparative efficiency of the French and British methods of culture, practical suggestions for the improvement of existing beds and the acquisition of new ones, and the like. No systematic effort seems to have been made to understand the early life-history of the mussel, and it was with the view of unravelling this that, at the request and under the guidance of Professor M'Intosh, the writer made a series of observations during the summer and early autumn of this year (1885).

If a mussel in a matured condition is cut from its shell, the whole outer envelope or mantle is seen to be filled with reproductive elements. Besides the mantle there is a central wedge-shaped mass behind the foot —the 'abdomen'—which is also filled with them. This organ is connected with the mantle in the pericardial region. The outer wall of the liver (a dark-coloured organ anterior to the foot) is usually devoid of the dendritic sperm-sacs or ovaries, but in an occasional example they are seen to ramify there to a small extent, as outgrowths of the abdominal mass. This is a condition in striking contrast with what obtains in the horse mussel (*Mytilus modiolus*), a much larger species inhabiting deep water. In it there is no trace of reproductive follicles in the mantle, but these proceed forward from the greatly enlarged central mass, and in many cases almost completely hide the liver. In both species of mussels the female reproductive organs are almost invariably of a deeper red or orange tinge than those of the male. (Half-sized specimens of both sexes may be found with the organs pale). Methylated spirit immediately extracts the colouring matter. A close inspection enables one to distinguish the sexes by the naked eye, the sperm-sacs being mostly arranged in more prominent groups than the ovigerous masses. There is probably no means of discerning the difference by any feature in the exterior of the shell. The spermatozoa of the common mussel have a characteristic shape, differing distinctly from those of the horse mussel. The former have a balloon-shaped head, tapering continuously off to a fine tail, whereas the head of the latter has a constriction where it tapers off to the tail. When an incision is made in the fully-ripe male organ a creamy fluid issues, containing immense numbers of spermatozoa, the motion of which is well described as 'dancing.' The milkiness is in proportion to the ripeness of the specimen. If the spermatozoa are in packets or groups, they are probably unripe. When the ovarian tissue is cut into, the fluid therefrom

containing the ova is orange-coloured. Many of the ova thus extruded have a translucent investment, discernible on account of floating debris being unable to reach the egg-capsule. Under the least pressure the ova appear oval; they are, however, quite circular when fully ripe, and at that time the large germinal area and distinct germinal spot previously seen are lost to view, the vitellus becoming densely granular. Viewed by transmitted light under the microscope, they have a brown tinge; by reflected light they appear as minute white specks, individually barely visible to the naked eye. The pale genital canal on each side is readily seen in the angle formed by the abdomen and the upper or attached margin of the inner gill. Microscopic sections show it to be clothed internally by ciliated epithelium. Entering into the generative organ, it divides into smaller canals which lead to the sperm- or egg-follicles. The natural method of fertilisation is not yet fully inquired into. In all probability the ova are carried by the efferent currents into the surrounding water, and there fertilised by the spermatozoa similarly evacuated. Artificial fertilisation is accomplished in the following way:—A piece of tissue containing spermatozoa is minced in a watch-glass with sea-water. A little of the milky liquid is poured into another glass and more water added. Into this is poured some liquid containing ova procured in the same way. The two elements are then mixed by gentle stirring, and the glass is set in a cool place for half an hour. The milkiness must then be completely removed by repeatedly emptying and refilling the vessel with a pure supply of sea-water, allowing the ova to settle to the bottom each time. Any debris left may be picked out by a fine pipette. With patience this can be very successfully done, and speedy putrefaction will be prevented. If the ova are now examined microscopically, each will be found to have a considerable number of spermatozoa attached to it, and their wriggling causes it to rotate. Fresh supplies of sea-water must be given at intervals. In about four hours the first indication of successful fertilisation is seen, the polar or direction-cell then making its appearance.

The latest attempt to fertilise eggs was made on the 7th August, and it failed. That of 1st August was partially successful. The most successful effort was the first, made in the early part of June. The results as to the time certain stages are reached in the different series are conflicting, due no doubt to the decreasing vigour of the generative elements. It is evident that as autumn advances the spermatozoa left in the organs lose their activity, and the percentage of good ova is smaller. The first segmentation takes place immediately after the appearance of the polar cell, resulting in a larger segment (macromere) and a smaller (micromere). Repeated budding of the micromere takes place, and in six or seven hours the embryo has assumed its most irregular condition, that is, it appears as a large cell, round one pole of which are grouped many smaller cells. Thereafter it assumes a form approaching the spherical, and in ten hours the brownish granular contents give place to colourless translucent globules and refracting particles. In fifteen or eighteen hours the shape is nearly spherical, and the contour is broken by the projecting part of what in all probability is the still undivided macromere. This body in some is almost enclosed by the cap of cells which are presumably the product of micromeral segmentation. In others it may still project considerably, and give indication of bipartition. The polar cell is usually now to be seen in the periphery, asymetrically placed in relation to the macromere. An unexplained feature is the crenate outline of the projecting portion of the latter. The gastrula stage is now reached, characterised by the appearance of a large cavity lined by the micromeral spherules and many smaller highly refracting cells. In gastrulæ of sixteen hours on more than one

occasion an opening into the cavity—the blastopore—presented itself indistinctly. An hour or two before this period cilia appear, and they now cover the greater part of the surface of the embryo, causing it to swim about and rotate actively. At forty-three hours from the time of fertilisation two examples (of distinct series) were characterised by having, besides the usual covering of minute cilia, in the one case one strong cilium at least as long as the diameter of the embryo, in the other by two cilia somewhat longer. In both embryos there were features indicating approaching differentiation of structure. Embryos have been kept alive beyond the age of the above—in fact, for four days—but as consecutive data of development were not secured, and occasionally other forms were accidentally introduced with the fresh supplies of water, it is advisable to corroborate the notes and drawings made. Failing to solve the whole problem by artificial means, many searches were made for embryos in pools at the mussel-beds of the Eden, in the river itself, and in tidal pools floored with mussels on the coast. The season was well advanced before this was done; nevertheless it is puzzling to understand why intermediate stages were not found, seeing that mussels still bearing sexual elements were abundant. None were found younger than those already referred to as having been got by Professor M'Intosh on the surface of St Andrews Bay. In material dipped from the surface, off the mouth of the Firth of Forth, on August 29, this year, the writer found many young mussels. The very youngest of them had a velum or ciliated swimming organ, which could be retracted within the delicate and transparent shell-valves with great alacrity. The hinge-line was long and straight. The embryo mussel is at this stage many times smaller than that figured by Lacaze-Duthiers, as bearing the four gill-lamellæ. In more advanced forms the velum had become useless as a swimming organ, the œsophagus or passage into the alimentary canal was seen as a wide tract thickly clothed with strong, active cilia, and the rudimentary eye-spots, liver, kidneys (organ of Bojanus) and adductor muscles of the shell could also be observed. In still more advanced examples the gill-lamellæ appear, and the umbones or beaks become elevated, so that the valves on lateral view are oval or nearly circular. Still further advanced forms exhibit a foot, otoliths rotating in the auditory capsule (a rudimentary organ of hearing), and many more closely set gill-lamellæ, while the other organs are correspondingly developed. By-and-by the young mussels sink to the bottom, and acquire round the margin of the embryonic shell a calcareous deposition of a prismatic structure, forming a blue rim, which extends most rapidly in an antero-posterior direction; and they thus gradually assume the shape of the adult. The foot of the young forms is ciliated, adhesive, extremely extensile, and is the means of awkward, but active locomotion. It is protruded forward a distance at least equal to the length of the mussel's body, is fastened by its adhesive property, and then contracted, thus dragging its owner along as it lies on its side. Progression is also aided by a gliding muscular movement of the foot. When a suitable position is reached the young mussel fixes itself there by means of its byssus or anchor-threads.

Amongst the smallest samples of a previous season, taken from the tidal rocks, the writer found that many, not more than one-eighth of an inch in length, contained in their tissue either ova or spermatozoa, presenting no appreciable difference from those taken from the full-grown adults. The above were probably not more than one year old. The fact that mussels have the power of reproduction from so early a stage leads one to think of their enormous fecundity, and to consider the practical aspects of the investigation. Great tracts of tidal rock-surface around our coasts are black with the carpeting of young mussels, but these being densely crowded, out of

the reach of food, and exposed to the buffetings of the waves, seldom grow to a useful size.

The cultivation of the mussel for sale is carried on in the estuary of the Eden, bringing a revenue to St Andrews on an average of £500 per annum. The beds ('scalps' or 'scaups') are mostly formed on muddy flats, uncovered at low water. They are cropped in rotation. The 'seed,' consisting of young mussels from half an inch to one inch or thereabout in length, are dredged from parts where they have been deposited naturally. These parts have in many cases previously carried a crop of mussels. The 'seed' may, however, be grown on places unadapted for rearing saleable mussels. The rate of growth is very rapid, an inch to an inch and a half in a year being no uncommon addition to the length. The rate depends on conditions, which may be regulated to some extent. Other things being equal, it seems to be the case that the longer the mussels are dry between tides the slower is their growth. The quickest growth is made by those lying in the bed of the stream, when they are never uncovered. Hence the opinion that, broadly speaking, the higher the beds are above the sea-level the less chance of success. The level of the 'scaups' is gradually being raised by the detention of silt amongst the mussels, and no attempt is made on an extensive scale to lower it. The mussels grown in the Eden are used for bait only. Professor M'Intosh recently had a few hurdles erected there for the purpose of investigating the suitability of the site for the cultivation of mussels for human food. They have become densely covered with young mussels, but it remains to be seen whether, with careful thinning and cleaning, the project may be profitably carried out.

APPENDIX F.—No. XV.

ICHTHYOLOGICAL NOTES. By George Brook, F.L.S.

(Plate IX.)

1. *Sebastes Norwegicus* (Ascam.) Norway haddock or Norwegian carp. —This is a northern form, and is only occasionally met with on our coasts. A specimen was forwarded by the Fishery officer at Berwick on the 19th of May 1885. It measured 8 inches in length, and was of a bright red colour when received. The specimen from Shetland, recorded in the 'Fishery Board Report' for 1883 as *Serranus cabrilla*, should have been described as *Sebastes Norwegicus*.

2. *Carelophus ascanii* (Walb.).—A specimen of this pretty blenny was captured in May last, between tide marks, in front of the Fishery Board Laboratory at Tarbert, Lochfyne. So far as I am aware, the only other record of this species as occurring on the West Coast of Scotland is that given by Fleming, who found it in Loch Broom. In the copy of Yarrell's *British Fishes* in the Edinburgh University Library, there is a note in pencil to the following effect:—'Twice taken on the shores of Rothesay Bay. 'J. M.' There is no date given, and I do not know by whom the record was made. The Tarbert specimen was kept alive in the laboratory for two months. During this time it was very sluggish, and often hid itself under stones. I have frequently observed this fish to rest with its tail curved round towards the head in the manner described by Peach. The fish did not feed well in confinement, and probably this was the cause of its death.

The specimen is $6\frac{1}{4}$ inches long, and of a deep, red-brown colour, paler on the ventral surface. There were none of the darker transverse bands usually found in this species. The supraorbital tentacles were well developed and very much branched; indeed, quite plumose. The first three rays of the dorsal fin each end in a plumose tuft, the anterior one the largest. The pectoral fin is more rounded than that figured by Day (*British Fishes*, vol i. pl. lx. fig. 3), and only reaches within half an inch of the anal. I notice that in his account of the generic character of *Carelophus*, Day says the lateral line is absent. In his figure, already referred to, a lateral line is, however, shown. This proceeds in a straight line forwards from the centre of the caudal fin to a point over the vent. It then takes a slight curve upwards, and terminates about the centre of the upper margin of the operculum. In the specimen here referred to the lateral line is quite distinct, and extends in a straight line for the whole of its length, and terminates at the point of union of the branchio-stegal rays with the apex of the operculum. The bathymetric range of this fish is very considerable. In Scotland it has frequently been captured between tide marks. M'Intosh records it as not uncommon in deep water at St Andrews, and states that it is occasionally found in the stomach of the cod. In the south of England it frequents the deeper water, and is rarely found at a depth of less than 5 to 8 fathoms (Day), while during the 'Porcupine' Expedition it was taken between Shetland and Faro at a depth of 180 fathoms.

3. *Ctenolabrus rupestris*, L. The goldsinny, or pink brame.—This species of wrasse does not appear to have been often recorded from the Scotch coast. Edward records one specimen at Banff. Parnell says it is occasionally cast ashore in the Firth of Forth, and Johnston obtained three near Berwick in 1836. I have found it frequently in Loch Fyne from May to August, particularly near the east shore of the Loch. It is local in its distribution, but is usually taken in considerable numbers where found. I found it to prefer a depth of 10 to 15 fathoms, and seldom met with it in shallower water. Examples which were preserved vary from $3\frac{1}{2}$ to $5\frac{1}{2}$ inches in length. The dark spot at the base of the caudal fin near the dorsal surface is very marked. The dark patch on the dorsal fin extends over the first three rays, though occasionally it may be a little longer. The teeth are in several rows, the outer of which is very well developed. The three anterior rays of the anal fin contain well developed spines. This species spawns in June in Loch Fyne, and the eggs are pelagic. Two batches of eggs were laid in one of the tanks at Tarbert, but they were not fertilised. The eggs after preservation have a diameter of about ·81 mm., and do not contain a distinct oil-globule.

4. *Centrolabrus exoletus*, L., the small-mouthed Wrasse, or Rock Cook. —A specimen of this species was taken in a trawl near Tarbert in June last, and another in July. In the latter case there were several *Ctenolabrus rupestris* in the same haul. In general appearance the two species are very similar, and the present species might easily be overlooked. Its body is, however, more flattened and deeper than that of the previous species, and there are no dark patches at the base of the caudal or at the anterior extremity of the dorsal fin. The anal fin has five spines. The teeth are in a single row, and very much smaller than in the preceding species. The Tarbert specimens are about 5 inches in length, and one is a little mottled with small black spots. So far as I am aware the only other Scotch localities for this fish are Kirkwall (Baikie) and Banff (Edward). It is essentially a northern species, but appears to be frequently met with on the South Coast of England.

5. *Motella cimbria*, L., Four-bearded Rockling.—A small specimen of

this fish, 7½ inches long, was captured off the Firth of Forth on 8th February 1886, and presented to the Board by the Granton Steam Trawling Company. This species has occasionally been met with along the East Coast of Scotland before, but is not common at any part of the British coast. In the specimen referred to the dark spots on the dorsal and anal fins are well pronounced, and the caudal extremities of these fins are not so square as those given in Day's figure (*Brit. Fishes*, vol. i. pl. 88, fig. 1); indeed, they more nearly resemble the terminations of these fins in *M. tricirrata*. The anal fin is 3½ inches long, while the length of the posterior portion of the dorsal is 4½ inches. The anterior ciliated portion of the dorsal, the rays of which are very short, is kept in constant vibratile motion when the fish is alive, and a distinct current is produced in the water.

6. *Motella tricirrata* (Bl.), Three-bearded Rockling.—A fine specimen of this species was received from Mrs Stewart of Leith. It was caught on the 7th January 1886, in the Firth of Forth, between May and Bass. It is a male, and measures 18½ inches in length. The margins of the fins were blood-red. The species is not particularly rare, but it is seldom so fine an example is secured. The largest British specimen recorded was 20 inches long (Thompson). It is curious to note that all the specimens examined by Day and Thompson were males; and it is very desirable that the sex of all specimens captured should be ascertained, as the absence of females seems unaccountable. In this specimen the testes were not well developed. Its ally, *M. mustela*, spawns in the summer, and the eggs are pelagic.

7. *Phycis blennoides*, Greater Fork-beard.—One or two specimens of this species seem to be captured yearly on the East Coast. Specimens were recorded in the Second and Third Annual Reports of the Fishery Board. A good specimen, 24 inches in length, has recently been sent to the Central Laboratory by the Fishery officer at Peterhead. The fish was seen swimming at the surface off Burnhaven, on 17th February 1886, and was secured by means of a clip. This makes the fifth specimen that has come under our notice in three years.

8. *Hippoglossus vulgaris*, L., Holibut.—A large holibut captured off the Berwickshire Coast on the 18th of May was found to contain nearly ripe ova. The fish weighed 91 lbs., and was taken by a Pittenweem great line boat 100 miles off St Abb's Head. The Fishery officer at Berwick informs me that holibut are rarely landed there with the ova so well developed. A part of the ovary, weighing 6 lbs., was sent fresh to the Central Laboratory. It was estimated that the part sent was about one-third of the whole ovary, which must have therefore weighed close on 18 lbs. The eggs were in three stages of development:—

(1.) The bulk consisted of unripe ova about 2·55 mm. in diameter, which were yellowish in colour and very oily outside.

(2.) Nearer the centre there were patches of ova similar in size to the above, but white and opaque. In these a large number of yolk spherules could be made out.

(3.) Amongst the patches of opaque eggs were little clusters of larger ova, which were quite transparent, and showed no division of the yolk into small spherules. It is probable that these eggs were quite ripe. They floated at first on being placed in sea-water, but being dead they soon sank to the bottom. The largest measured about 4·25 mm. in diameter. I did not not notice any oil globule.

In order to estimate roughly the number of ova in the whole ovary an ounce of the smaller eggs was weighed, and the number counted. There were 5530 eggs to the ounce. Taking off 3 lbs. for the weight of the

ovary, and reckoning only 15 lbs. as the weight of eggs which it contained, we get 1,327,000 as the number of eggs in a fish of 91 lbs. weight. This, of course, is only a rough calculation, but will give an idea of the immense number of eggs produced by this species.

9. *Zeugopterus unimaculatus* (Risso).—I took this species on several occasions in Loch Fyne during last summer, mostly in a small sandy bay on the west shore. It seems to be fairly common in that particular spot, as on one occasion I took three specimens at one haul of the trawl. Another specimen was taken near the east shore of Lochfyne in 10 fathoms of water. It lives well in confinement; and we kept two specimens alive all the summer and autumn, and they were only preserved when the station was closed for the winter. It swims about with a graceful undulating motion of the vertical fins, resembling the movements of a sole rather than those of any of the species of *Pleuronectes.* The vertical fins almost meet under the tail, and in the terminal portion the rays are very flexible, and not covered with spinous scales as is the case with all the other rays of the dorsal and anal. The first ray of the dorsal is produced into a somewhat long, fleshy filament, which is sometimes branched. The distribution of colour in this species is very effective, and the large central spot, often edged with white, which is situated on the lateral line some distance in front of the tail, is very well marked. The amount of the darker shades present (which vary from brown to an intense black) varies very much with the light and the nature of the bottom. Sometimes the specimens were marbled all over with black and white in broad, irregular patches. At other times the general ground colour was a lightish brown marbled with yellowish patches and dark brown spots, and with a number of brilliant red spots about the size of a pin's head. At such times the central large spot already referred to is brought out in great relief, but it can always be made out even when the general body colour is almost black.

The specimens which I have obtained differ in many minor points from the figure given by Day (*British Fishes*, vol. ii. pl. 99 fig. 1). The lower jaw is not curved, and the interorbital ridge is not prominent in living specimens. These effects may, however, be produced in specimens preserved in strong spirit. The pectoral fin has not the thickened and prolonged spine shown in Day's figure. The anal fin gradually narrows anteriorly and terminates *between* the two ventral fins but is not attached to them. The angle of the vertical fins in the caudal region is usually not so marked as in Day's figure; the rays gradually decrease in size near the margin of the caudal, where they are scarcely one-sixth of an inch in length, and then become longer again under the caudal forming the 'accessory portion' already spoken of. The markings on the upper surface vary considerably, both in size and intensity, but the one spot on the lateral line is prominent and constant. It is, I suppose, for this reason that the species has received the name *unimaculatus.*

There are also a number of short fleshy filaments studded around the base of the vertical fins, and more sparingly over the general upper surface. These are usually black, but in the lighter areas some are very pale.

In confinement the specimens usually adhered to the sides of the tanks in which they were placed, and were seldom found on the bottom, even when this was covered with sand. This fact seems curious, as in their natural habitat they were found in a small sandy bay overgrown with *Zostera marina.* In a glass tank their habits could be easily watched. The fish on approaching a side of the tank would press itself flat against the glass, and then, with a slight backward pressure of the rays of the dorsal and anal, the body is raised up a little from the surface of the glass,

leaving the fins tightly pressed against it. The fish would remain in this position for hours if not disturbed. It has already been stated that the basal portions of the dorsal and anal fins are different in structure from the remaining parts. The object of this is now obvious. When the fish is in the position described a constant current of water is made to pass out from the branchial chamber on the lower side, along the channel caused by the arching of the body, by a rapid movement of the basal portion of these fins. The motion is usually incessant and very quick, resembling that of cilia. Occasionally when there are particles of debris suspended in the water these may be seen to pass rapidly out of the branchial chamber, and then to travel more slowly along the body axis, and finally to be drawn out with a rapid whirl by the action of the accessory portions of the dorsal and anal fins. During normal respiration the lower jaw shows little or no movement, and the dilation and contraction of the opercular membrane on the upper side is scarcely noticeable. The accessory portions of the vertical fins appear then to be specially constructed to aid in the respiratory function. So far as I know, this peculiar adaptation is not met with in any other genus of British Fishes. In *Z. punctatus* there are similar accessory portions to the vertical fins, and although I have not seen this species alive, it is to be presumed that they serve the same purpose.

I have to thank my friend Mr W. L. Calderwood for the figure of this species, which is a life-size representation of the largest Tarbert specimen (Plate IX.). A drawing of the accessory portion of the vertical fins, as seen from the under surface, will also be found on the same plate.

A specimen, caught in 10 fathoms on the 13th of June, was a ripe female, and measured 5 inches in length. A number of eggs were laid in confinement, but as we had only the one specimen at the time, they were not fertilised. The eggs are very buoyant, and rise at once to the surface of the water. The eggs are quite transparent and contain a small yellowish oil-globule. I had no means of measuring the living eggs, but those preserved measured about ·96 mm in diameter.

This species appears to be very rare all around the British Isles. Fleming recorded one specimen from Zetland, and Johnston mentions it as occurring on the Berwickshire coast. In 1860 Ferguson took one off Redcar, in Yorkshire; and specimens have also been taken off Plymouth, Weymouth, and the Cornish coast. One specimen was taken in Belfast Bay in 1838, and two others are recorded from the same locality in 1844.

There is another specimen in the collection of the Fishery Board, probably from the West Coast, but I do not know when or where it was captured.

10. *Zeugopterus punctatus* (Bl.).—This species is met with much more frequently than *Z. unimaculatus*, but still it is by no means common, at any rate around the Scottish coast. A specimen was obtained in the Firth of Forth last June, and forwarded to the Central Laboratory by Mrs Stewart of Leith. The fish measured 7 inches in length. Another specimen has been forwarded by the Fishery officer at Montrose. It was caught by a steam trawler about 8 miles S.E. of Wick Bay on the 24th of February 1886. The bottom was sandy and the depth of water about 32 fathoms. The specimen is 7½ inches in length.

11. *Pristiurus melanostomus* (Raf.), Black-mouthed Dog-fish.—This species is common in the Mediterranean, but has not been often recorded around the British Isles. Specimens were sent to Yarrell from the West Coast of Scotland (Malcolm). Edward is led to believe that this species occurs occasionally off Banff; and a specimen was taken at Polperro, in Cornwall, in 1834. These are all the localities given in Day's *British Fishes.*

The dog-fishes being of little or no use as food, seldom reach our markets; and as Dr Day has suggested to me, it is probable that a closer search may prove this species not to be so rare around our shores as has hitherto been supposed.

At Tarbert (Loch Fyne), during the winter fishing, the dog-fishes are thrown into the harbour when the boats come in, and large numbers are often left on the beach as the tide goes down. These are nearly all the picked dog-fish (*Acanthias vulgaris*). In March last I met with two specimens of *Pristiurus* amongst them, but the season being nearly over, I had missed the opportunity of ascertaining the comparative frequency of this form. Large numbers of *Acanthias* were brought in by the herring boats in the summer and autumn, which I frequently examined, but never found a specimen of *Pristiurus* amongst them. In the spring a specimen was captured in Rothesay Bay, and kept alive for some time in the Rothesay Aquarium.

12. *Læmargus microcephalus* (Bl.), Greenland Shark.—A specimen of this shark was obtained by the Granton Steam Trawling Company, in the Firth of Forth, 8 miles S.E. of the Island of May, on 20th January 1886. The specimen was a female, and measured 11 feet in length. This species is evidently fairly common in our seas. The special interest attaching to the capture of this specimen is that it was taken in a beam trawl. When brought to the surface 3 cod-fish hooks with snoods attached escaped from its mouth, and another was found attached at the back of its throat. In the same haul there were 4 herring (nearly ripe) and a specimen of the sea bream (*Pagellus centrodontus*).

Another specimen, a young female, measuring 5 feet in length, was obtained in the Firth of Forth on 2nd February. Both specimens were dissected by Mr Calderwood, who contributes a paper on the subject to the present report.

13. *Rhina squatina* (L.), Monkfish, or Angel Shark.—This fish is usually considered rare on the East Coast of Scotland, though it has been recorded from several localities. According to Day, it is common in the North Sea and British Channel. A specimen was sent to us by the Fishery officer at Aberdeen, which measured 42 inches in length. It was captured by the trawl on 6th August 1885. Mr Sim recorded this species from the same locality in January 1883.

APPENDIX F.—No. XVI.

NOTES ON THE GREENLAND SHARK (*Læmargus microcephalus*),

By W. L. CALDERWOOD. With Plate X.

THE Greenland shark is described by the various ichthyologists as a fish rarely straying to the British shores. Its natural home is doubtless in the colder waters of the Arctic Circle, where it is said to occur in considerable abundance; but when its occurrence is compared with that of the more truly British sharks, it would appear to be at least as common in our waters as any other. Since 1803 there are records of its capture which go to prove that scarcely a year passes without one or more specimens being obtained, and it is worthy of note that nearly all these specimens were captured on the East Coast. The most southerly point from which this shark is recorded is the Seine, where one was taken in 1832.* Three were caught off the Bell Rock in 1873, and two at Scarborough in 1878. Three specimens are recorded from Aberdeen, and two from the Dogger Bank, besides a number of single ones from different parts of the coast.

The two which I dissected were caught, within a few days of each other, in January of this year. The first was a fine specimen 11 feet long, which was brought up by one of the trawlers of the General Steam Fishing Company 8 miles SE. of the May Island. When it was slung up clear of the water, a cod and three baited hooks with snoods attached fell out of its mouth, and I afterwards found a large cod hook fixed in the gullet. Its stomach contained one herring, five cod, one conger eel, and a considerable quantity of partly digested fish.

The second shark was only 5 feet long, and was caught by line fishermen. The stomach of this one contained three herrings and about a score of cuttle fish beaks.

The distinctive characters of the Greenland shark, as given by Günther and Day, may be said to be the following:—All the fins small and spineless; two dorsal and a pair of anal fins. Skin uniformly covered with minute tubercles. Nostrils near the extremity of the snout. No nictitating membrane to eye. Mouth with a deep oblique groove at its angles; the upper teeth small, narrow, conical, and in several rows; the lower teeth more numerous than upper, also in several rows, each tooth having its point so much turned aside that the inner margin forms a cutting, non-serrated edge. Spiracles of moderate width.

Almost invariably when this shark is captured, a parasite, *Lerneopoda elongata*, is found attached to one or other of its eyes. In the first of the two sharks mentioned, the parasite was on the right eye, and had attained the length of fully 2 inches. In the smaller specimen both eyes were affected in this manner.

Taking the larger shark,—the mouth had a transverse diameter of about 1 foot. The teeth have already been described; there were six rows in the upper and eight in the lower jaw. The œsophagus was wide and elastic, so that any large body taken into the mouth could readily be swallowed. The stomach was an immense oval sac, with a peculiar arrangement at its pyloric extremity. This was first described by Professor

* Day's *British Fishes*, vol. ii. p. 321.

Turner,* and in so able a manner that I cannot do better than quote his words. 'The stomach possessed the "siphonal" form met with in so 'many fish, but the pyloric tube, instead of arising directly from the great 'sac of the organ, as is the case in the *Selache maxima* and various other 'sharks, proceeded from a "pyloric compartment." Its opening into this 'compartment was so constricted that I at first regarded it as the proper 'pyloric orifice, and it was not until I had slit open both the pyloric tube 'and the duodenum, that I recognised the former to be, not the com-'mencement of the intestine, but the tubular pyloric termination of the 'stomach.

'The cylindrical duodenum, its very considerable length, and the 'absence of any dilatation, such as constitutes the *Bursa entiana* pro-'perly so called, formed most important features of difference between 'this fish and the sharks generally. The cylindrical form resembled 'indeed the duodenum of the sturgeon, though it did not possess that 'double turn which Carus has figured in the intestinal tube of the latter 'fish. The coexistence of a well-developed pancreas, with two large cœca 'opening into the commencement of the duodenum, is an anatomical 'arrangement which had not previously been recognised in the plagiosto-'mata. If we are to regard these cœca as homologous with the pyloric 'cœca in osseous fishes—and their relations to the duodenum, both as 'regards their situation at its pyloric end, and the continuity and struc-'tural correspondence of their coats with the serous, muscular and mucous 'coats of the intestine point of this homology—then a most important 'piece of evidence is furnished against the view so generally entertained 'by anatomists that the pyloric cœca are the homologues of the 'pancreas.'

The mucous membrane lining the stomach was puckered into a series of convoluted folds. The pyloric tube opening from the 'pyloric compartment' of the stomach was from three-quarters of an inch to an inch in diameter, by about six inches in length, and so united to the short cœcum that the two could not be distinguished by an external view. This shark seems to feed largely on fish; but a porpoise and great pieces of whale blubber have been taken from its stomach.

In tracing the duodenum onwards, it was seen to become contracted before passing into the spiral valve. This contraction was itself a valve, whose muscular walls were so thick as only to admit the tip of one's little finger. The spiral valve or colon took thirty-two turns before passing into a short muscular rectum, to which a somewhat small rectal gland was attached. The liver was divided into two lobes, which extended the entire length of the abdominal cavity (nearly 6½ feet). Imbedded in the root of the left lobe was the gall bladder, an almond-shaped organ 7 inches long.

The specimen was a female. The ovaries were about 21 inches in length and situated in the anterior portion of the abdominal cavity. They were divided transversely into a number of lobes. The capsule of some of these lobes was exceedingly thin, or even appeared to be absent, revealing numbers of eggs lying in the stroma, varying in size from small shot to large peas. The oviducts have a common funnel-shaped opening above the œsophagus, as in the skates. They extend, one on either side of the middle line, the whole extent of the abdominal cavity. There is no trace of an oviducal gland; but after passing the level of the ovaries, the oviducts dilate slightly, forming a pair of structures resembling uteri. The dilatation was not great, but the ovaries were unripe. Laemargus is in all

* *Journal of Anatomy and Physiology*, vol. vii. p. 145.

probability viviparous. The cloaca is divided into two compartments, an upper and a lower. Viewed from the ventral aspect, the upper has only the rectum opening into it, while the lower has the two oviducts, one on either side, and a little behind, the urinary papilla, which has at its summit the common opening of the two ureters. Two abdominal pores open just beyond the posterior margin of the cloaca.

The heart was enclosed in a strong pericardium and was of the ordinary elasmobranch type. The sinus venosus was inside the pericardium. The bulbus arteriosus was of similar construction to the ventricle, on which account Gegenbaur describes it as an elongated, and to some extent independent, segment of the ventricle, homologous with the conus arteriosus in the higher vertebrates rather than with the bulbus of osseous fishes. On cutting it open longitudinally, it was seen to have four rows of valves and a single representative of a fifth row. All the valves were attached to the muscular wall by cordæ tendineæ. Four afferent vessels spring from the ventral aorta on each side, the most anterior pair dividing into two. This arrangement is similar to what I have seen in other sharks, the only difference being that in this case the first two pairs of vessels have their origins close to one another, whereas in others, Galeus for instance, the intervals between the vessels are more regular.

The two posterior cardinals run parallel and on either side of the back bone, and on reaching the anterior end of the abdominal cavity, become enveloped in a common covering; they are still separated, however, by a more or less porous septum. Each then dilates into a large hepatic sinus, so that the blood entering from the liver cannot pass into either sinus of Cuvier, as it can in the skate for instance; but, practically, is compelled to pass either to the right or left according as it has come from the right or left lobe of the liver. The size and arrangement of these hepatic sinuses no doubt corresponds to the extent of the liver.

The brain of this, as of many other sharks, lies in a cavity very much too large for it. It was itself small, and closely resembled, both in structure and size, that of a good sized skate. The cranial cavity proper was $9\frac{1}{4}$ inches long, *i.e.*, not including the wide branches which passed off to the olfactory region or the large tube in which the anterior portion of the spinal cord lay. Immediately above the cerebral lobes the cavity was deepest, being $2\frac{5}{8}$ inches, and about an inch further forward attained its greatest breadth of $2\frac{1}{2}$ inches. The walls and roof of the cavity had a gently undulating surface, and were lined by what appeared to be a recticulated vascular membrane. The cartilage of the brain-box was exceedingly thick in the regions of the auditory and nasal capsules, but above the cranial cavity, measured only about an inch and a half. The olfactory bulbs, eyes, and ears were all large and well developed.

The skeleton was *entirely* cartilaginous, no trace of ossification being found either in the head, jaws, or backbone. A longitudinal section of the latter taken about the middle of the animal showed only slender strips of cartilage segmenting off the notocord, the strips occurring about six inches from one another. Tracing it backwards towards the tail, the strips became thicker and the amount of notocord in each segment smaller, until in the caudal fin they were in about equal proportions. All the cartilage was very soft and flexible, so much so, that even several days after death the whole body could be bent freely in all directions. The muscles of the trunk are of a peculiar creamy-white colour and soft, though of great thickness along the back. The *young* Greenland shark is of a dull slate colour and there are a number of small white spots distributed in an irregular manner

over the surface of the skin, each spot having in its centre an opening of a mucous canal. In the old shark the skin has more of a blue tint, and the white spots are absent. Mucous canals open nevertheless in great numbers, particularly in the region of the head, where they are arranged in rows.

DESCRIPTION OF PLATE X.

Reproductive organs of young shark—œsophagus cut through, and cloaca slit up, so as to show the two compartments, the openings of the oviducts, and the common urinary opening at the summit of the papilla.

APPENDIX F.—No. XVII.

LIST of the MARINE FAUNA collected at the Tarbert Laboratory during 1885. Part 1. By George Brook and Thomas Scott.

The present list does not pretend to include a complete list of the forms known to inhabit Lochfyne and the adjacent waters, but simply includes those species which have been collected and identified in connection with the enquiries at present in progress in Lochfyne under the direction of the Fishery Board.

The large group of Amphipods have not been included in the present list of Crustacea, as many species have not yet been identified. Other groups, such as the Cœlenterates, Sponges, Annelids, Tunicates, &c., have not received special attention, and will be worked up later.

Our thanks are due to the Rev. A. M. Norman for the very valuable assistance he has rendered us in the identification of the Crustacea, who contributes a paper on some of the more interesting forms.

In order to add to the value of the present list, an asterisk has been placed in front of each species which is known to form a part of the food of fishes.

PISCES.

Teleostei.

Cottus scorpius (Bloch) (father lasher), common.
" " var. *grœnlandicus*, frequent.
" *bubalis* (Euph.) (long-spined cottus), common.
Trigla lineata (Gmel.) (streaked gurnard), not common.
" *gurnardus*, L. (gray gurnard), common in East Loch Tarbert.
Agonus cataphractus, L. (pogge), occasionally.
Scomber scomber, L. (mackerel), abundant in the summer, particularly along the west shore of Lochfyne; captured in large quantities during the herring fishing in the seine nets.
Zeus faber, L. (John Dory), usually enter Tarbert Harbour in September to feed on the herring offal. Are present in the Sound of Kilbrannan considerably earlier, and are frequently taken off Carradale Pier.
Gobius ruthensparri (Euphr.) (two spotted goby), common amongst the Zostera beds in East Loch Tarbert.
" *minutus* (Gmel.) (one spotted goby), frequent in sandy spots in East Loch Tarbert but not so numerous as the preceding species. In confinement this species frequently buries itself in the sand.
Callionymus lyra, L. (dragonet), both males and females (= *Callionymus dracunculus*) are frequent but small.
Cyclopterus lumpus, L. (lump-sucker), we have frequently met with immature forms, some not over one inch long, but have not as yet dredged any large specimens.
Liparis vulgaris, L. (sea-snail), between tide marks.
" *montagui* (Donov.) (Montague's sucker), between tide marks.
Lepadogaster sp., Sunidale Bay, 10 fathoms.
Carelophus ascanii (Walb.), one taken amongst boulders at low water, East Loch Tarbert, also occurs in Rothesay Bay.
Centronotus gunnellus, L. (butter-fish), plentiful between tide marks.
Atherina presbyter (Jenyns) (atherine), frequent in a Zostera bed in East Loch Tarbert in the spring, but not met with later.
Gasterosteus spinachia, L. (fifteen-spined stickleback), abundant in Zostera beds in East Loch Tarbert.
Labrus maculatus (Bl.) (ballan wrasse), frequent in the autumn.
" *mixtus*, L. (striped wrasse), occasionally at the mouth of East Loch Tarbert.
Ctenolabrus rupestris, L., common, particularly near Skate Island, in 10 to 12 fathoms. Does not appear to frequent shallower water.
Centrolabrus exoletus, occasionally in Lochfyne.
Gadus morhua, L. (cod), not very abundant in Lochfyne, nor are the fish in good condition. The rock variety is found nearer shore. The principal cod fishing industry in this district is in the Sound of Gigha during the winter months.
" *œglifinus*, L., haddock, not abundant.
" *luscus* (Will.) (bib), occasionally in Tarbert Harbour.
" *minutus*, L. (power-cod), frequent in Tarbert Harbour.
" *merlangus*, L. (whiting), not abundant. Neither the whiting nor the haddock afford any systematic fishery in Lochfyne. A few are caught on hand lines in or near the harbours.

Gadus virens, L. (coal fish or saith), very abundant.
„ *pollachius*, L. (pollack or lythe), frequents rocky parts and is fairly abundant but usually small.
Molva vulgaris (Flem.) (ling), frequently brought in by the fishermen.
Motella mustela, L. (five-bearded rockling), rare, between tide marks, East Loch Tarbert.
Ammodytes lanceolatus (Lesaw.) (larger sand eel), occasionally. There is not, however, much suitable ground for this species in the neighbourhood.
Hippoglossus vulgaris (Flem.) (holibut), occasionally in Lochfyne. Larger specimens are captured in the Sound of Bute and Sound of Kilbrannan.
Hippoglossoides limandoides (Bloch) (long rough dab), taken during the winter fishing and from the Sound of Gigha.
Rhombus maximus, L. (turbot), occasionally.
Zeugopterus unimaculatus (Risso), we have secured a few specimens of this rare species from near Barmore.
Pleuronectes platessa, L. (plaice), fairly plentiful in suitable parts of Lochfyne.
„ *microcephalus*, frequent in suitable localities. There is a regular fishery for this species around the Island of Bute.
„ *limanda*, L. (common dab), Skipness and Barmore.
„ *flesus*, L. (flounder), common in Tarbert Harbour.
Solea vulgaris (Quen.) (sole), Barmore Bay, small.
Salmo salar, L. (salmon), occasionally taken in herring nets between Tarbert and Barmore.
„ *trutta*, L. (sea-trout), regularly taken in small quantities just outside East Loch Tarbert.
Clupea harengus, L. (herring), enters Lochfyne in May, and the fishing usually lasts until November.
„ *sprattus*, L.? (sprat), the sprat is not usually regarded as being present in the Firth of Clyde, but specimens sent from Girvan have been identified by Mr Matthews as sprats.
Anguilla vulgaris (Turt.) (common eel), affords a small but regular fishery in Tarbert Harbour.
Conger vulgaris (Cuv.) (conger-eel), frequent but small.
Siphonostoma typhle, L. (broad-nosed pipe fish), Zostera bed, East Loch Tarbert.
Sygnathus acus, L. (greater pipe fish), common.
Nerophis æquoreus, L. (ocean pipe fish), Zostera bed, East Loch Tarbert.
„ *lumbriciformis*, L. (worm pipe fish), Zostera bed, East Loch Tarbert.

GANOIDEI.

Acipenser sturio, L. (sturgeon), fine specimens are often noticed in Lochfyne during the herring fishery, but these are seldom captured.

ELASMOBRANCHII.

Pristiurus melanostomus (Bonah.) (black mouthed dog fish), occasionally brought in amongst the Acanthii in the winter fishing. Taken also in Rothesay Bay.
Acanthias vulgaris (Risso) (picked dog fish), very abundant and a perfect nuisance to the fishermen while prosecuting the herring fishery.

Raia batis, L. (common skate), fished principally in the winter and from the West Loch and Sound of Gigha.
„ *clavata*, L. (thornback ray), frequent during the winter fishing.

The above are all the species of fishes that have come under our notice at Tarbert during the past year; there are doubtless many more still to be recorded. The list of Elasmobranchs is very imperfect, no special attention having been given to this group.

BRACHIOPODA.

Terebratula caput-serpentis, L., fairly common off Battle Island in 40 fathoms, and in other localities.
Crania anomala (Müll.), abundant and large, near Maol-Dubh Point, 12 to 15 fathoms. Frequent also in other parts of the loch, usually at a depth of less than 20 fathoms.

MOLLUSCA.

LAMELLIBRANCHIATA.

ASIPHONIDA, Flem. (1828).

**Anomia ephippium*, L., common.
Ostrea edulis, L., generally distributed but small and scarce.
Pecten pusio (L.), a few off Skate Island, 14 fathoms, and East Loch Tarbert.
* „ *varius*, L., East Loch Tarbert.
„ *opercularis* (L.), common. The lower (convex) valve is frequently covered with a soft pink sponge, amongst which are specimens of *Tubularia*, &c.
„ *septemradiatus*, Müll., common and of fair size, but local. Exceedingly plentiful in the deep water (104 fathoms) off Skate Island.
* „ *tigrinus*, Müll., not uncommon off Battle Island (40 fathoms) and in other localities.
„ „ var. *costata*, Jeff. in 40 fathoms, off Battle Island.
„ *striatus*, Müll., Furlong Bay and Maol-Dubh Point. Not common.
„ *maximus* (L.), off Skate Island in 14 fathoms and in other localities, but not very plentiful.
Lima subauriculata (Mont.), dead shells off Battle Island in 40 fathoms.
„ *hians* (Gmel.), off Battle Island in 40 fathoms.
**Mytilus edulis*, L., Fairly plentiful in East and West Loch Tarbert generally. In the latter it is larger and more abundant.
„ *modiolus*, L., common.
Modiolaria marmorata (Forb.), imbedded in the mantle of *Ascidia mentula*, which is abundant on the long bank (10 to 16 fathoms) off the mouth of East Loch Tarbert.
„ *discors*, L., attached to roots of Laminaria, &c., East Loch Tarbert and other localities.
**Nucula nitida* (G. B. Sow), Battle Island, not common.
* „ *tenuis* (Mont.), occasional, off Battle Island.
**Leda minuta* (Müll.), off Battle Island.
Pectunculus glycymeris, L., single valve of a dead shell in coralline bed, 19 fathoms, Sunidale Bay.

SIPHONIDA, Flem. (1828).

Lepton nitidum, Turt., Sunidale Bay.
Montacuta bidentata (Mont.), East Loch Tarbert.
**Lasœa rubra* (Mont.), var. *pallida* (Jeff)., East Loch Tarbert.
Lucina borealis, L., dead shells frequent on the shore.
Axinus flexuosus (Mont.), East Loch Tarbert.
„ *ferruginosus* (Forb.), off Tarbert, 16 to 18 fathoms.
Cyamium minutum (Fabr.), White Shore, East Loch Tarbert.
**Cardium echinatum*, L., generally distributed.
„ *exiguum*, Gmel., East Loch Tarbert.
* „ *fasciatum*, Mont.
„ *edule*, L., more common in West than in East Loch Tarbert.
„ *norvegicum*, Spenz., single valves in East Loch Tarbert and in Lochfyne.
Cyprina islandica, L., dead shells, but fresh near Laggan; 30 fathoms.
Astarte sulcata (Da C.), Laggan Bay and East Loch Tarbert.
„ „ var. *elliptica* (Bro.), Laggan Bay.
**Circe minima* (Mont.), single valves and fresh dead shells.
Venus exoleta, L., dead shells, Sunidale Bay.
„ *fasciata* (Da C.), common.
„ *casina*, L., single valve, Sunidale Bay.
„ *ovata*, Penn., off Battle Island, muddy bottom, and in East Loch Tarbert.
* „ *gallina*, L., White Shore, East Loch Tarbert.
Tapes virgineus (L.), dead shell, Sunidale Bay.
„ *pullastra* (Mont.), common, White Shore, East Loch Tarbert.
Tellina crassa (Penn.), single valve, Sunidale Bay.
„ *balthica*, head of West Loch Tarbert.
„ *tenuis*, Da C., common.
Psammobia tellinella, Lamk., Sunidale Bay.
Mactra subtruncata, Da C., frequent, East Loch Tarbert.
**Scorbicularia alba* (Wood), off Battle Island, in muddy sand.
**Solen siliqua*, L., var. *arcuata*, Jeff., East Loch Tarbert.
Lyonsia norvegica (Chem.), Lochfyne, not common.
Thracia papyracea (Poli.), var. *villosiuscula* (Macg.), Sunidale Bay, recent, dead.
Neæra abbreviata, Forb., in the deeper portions of Lochfyne, rare.
„ *costellata* (Desh.), off Battle Island, 40 fathoms, rare.
„ *cuspidata* (Olivi), off Battle Island, rare.
Corbula gibba (Olivi), Lochfyne and East Loch Tarbert, not common.
Mya arenaria, L., West Loch Tarbert.
„ *truncata*, L., dead shells, East Loch Tarbert.
Saxicava rugosa, L., shores of East Loch Tarbert.
Xylophaga dorsalis (Turt.), about two hundred living specimens taken out of a small piece of wood dredged in East Loch Tarbert, also in similar situation off Skate Island.

SCAPHOPODA, Bronn (1862).

Dentalium entalis, L., common off Barmore and in other localities. Some of the dead shells are inhabited by Sipunculids.

GASTEROPODA, Cuvier (1798).

CYCLOBRANCHIATA (Cuvier).

Chiton fascicularis, L., rare, East Loch Tarbert.
,, *marginatus*, Penn., White Shore, East Loch Tarbert.
,, *ruber*, Lowe, under stones between tide marks.
,, *marmoreus*, Fabr., East Loch Tarbert, Sunidale Bay.
,, *sp.*, Sunidale Bay.

PECTINIBRANCHIATA, (Cuvier).

Patella vulgata, L., common and of large size.
Helcion pellucidum (L.), var. *lævis* (Penn.), White Shore, East Loch Tarbert.
Tectura testudinalis (Müll.), White Shore, East Loch Tarbert.
,, *virginea* (Müll.), Sunidale Bay.
Puncturella Noachina (L.), Laggan Bay.
Emarginula fissura (L.), off Battle Island and in other localities, dead shells.
,, *crassa*, J. Sow., off Battle Island, dead.
Capulus hungaricus (L.), Furlong Bay, 15 fathoms.
Trochus helicinus, Fabr., East Loch Tarbert.
,, *magus*, L., White Shore and Lochfyne.
* ,, *tumidus*, Mont., East Loch Tarbert.
,, *cinerarius*, L., common.
,, *umbilicatus* (Mont.), common near low-water mark.
,, *millegranus*, Phil., off Battle Island.
,, *zizyphinus*, L., Laggan Bay, and in other localities.
Lacuna divaricata (Fabr.), off Battle Island, and in East Loch Tarbert.
,, ,, var. *canalis* (Mont.), East Loch Tarbert. Both variety and type occur amongst Zostera.
,, *pallidula* (Dac.), on Laminaria.
,, ,, var. *albescens*, Jeff., E. Loch Tarbert.
Littorina obtusata (L.), common.
,, ,, var. *ornata*, Jeff., White Shore, East Loch Tarbert.
,, *rudis*, Maton., common.
,, *littorea*, L., common.
Rissoa reticulata (Mont.), off Battle Island.
,, *abyssicola* (Mont.), deep water, 50 fathoms.
,, *parva* (Da C.).
,, *membranacea* (Ad.), var. *elata*, Phil., East Loch Tarbert.
,, *violacea*, Desm., East Loch Tarbert.
,, *striata* (Ad.), common.
,, *cingillus* (Mont.), common.
Hydrobia ulvæ (Penn.) ? West Loch Tarbert, in quantity.
Skenea planorbis (Fabr.), common.
Homalogyra atomus (Phil.), scarce, East Loch Tarbert.
Cæcum glabrum (Mont.), Lochfyne and East Loch Tarbert, not common.
**Turritella terebra* (L.), dead shells, East Loch Tarbert.
Odostomia conspicua, Ald.
,, *unidentata* (Mont.).
,, *spiralis* (Mont.).
Eulima distorta (Desh.), Sunidale Bay and East Loch Tarbert.

**Natica Alderi*, Forb., East Loch Tarbert and off Battle Island.
„ *Montacuti*, Forb., off Battle Island.
Lamellaria perspicua (L.), on stones between tide marks, East Loch Tarbert, frequent.
**Velutina lævigata* (Penn.), East Loch Tarbert.
**Trichotropis borealis*, Brod. and S., Furlong Bay.
**Aporrhaïs pes-pelecani* (L.), Furlong Bay, off Battle Island, &c.

Siphobranchiata.

Cerithiopsis tubercularis (Mont.), East Loch Tarbert and Sunidale Bay.
Purpura lapillus (L.), common.
**Buccinum undatum*, L., East Loch Tarbert.
**Fusus gracilis* (Da C.), Lochfyne.
Nassa incrassata (Str.), East Loch Tarbert.
„ *reticulata*, L., East Loch Tarbert.
Defrancia linearis (Mont.), dead shells, off Battle Island and in East Loch Tarbert.
**Pleurotoma turricula* (Mont.), East Loch Tarbert (living), off Battle Island (dead shells).
Cypraea europea (Mont.), on rocks at extreme low water, Lochfyne.

Pleurobranchiata.

Utriculus truncatulus (Brug.), East Loch Tarbert.
„ *hyalinus* (Turt.), East Loch Tarbert.
Actæon tornatilis (L.), Laggan Bay,
Scaphander lignarius (L.), Furlong Bay and off Maol-Dubh Point in 15 fathoms.
**Aplysia punctata*, Cuv., White Shore, East Loch Tarbert.
Pleurobranchus plumula (Mont.), between tide marks, and dredged, East Loch Tarbert.

NUDIBRANCHIATA.

Pellibranchiata.

Elysia viridis, Mont., common in Zostera bed, East Loch Tarbert. Varies from pale green or brown to a dark sage green.

Polybranchiata.

Hermæa bifida (Mont.), East Loch Tarbert.
Eolis papillosa (L.), between tide marks, frequent.
Eolis Drummondi, Thomp., more common than preceding species. Immature forms are abundant amongst Zostera.
„ *alba*, A. and H., frequent in Zostera bed, East Loch Tarbert.
„ *Farrani*, A. and H., one specimen under stones, East Loch Tarbert.
Dendronotus arborescens (Müll.), frequent in Lochfyne, 10 to 20 fathoms.

Acanthobranchiata.

Ægirus punctilucens (d'Orb.), under stones, East Loch Tarbert.
Triopa claviger, Müll., between tide marks, East Loch Tarbert.
Polycera quadrilineata (Müll.), East Loch Tarbert.
„ „ *black* var. East Loch Tarbert.

Goniodoris nodosa (Mont.), East Loch Tarbert.
Doris tuberculata, L., East Loch Tarbert, frequent.
„ *Johnstoni*, A. and H., East Loch Tarbert, frequent.
„ *repanda*, A. and H., rare, East Loch Tarbert.
„ *pilosa*, Müll., occasionally, East Loch Tarbert.

PULMONIBRANCHIATA.

Melampus bidentatus (Mont.), common, East Loch Tarbert.

CEPHALOPODA.

**Sepiola Rondeletii*, Leach, Laggan Bay, eggs frequent, attached to Ascidians, &c.
Rossia macrosoma (Del. Ch.), Laggan Bay.
Octopus vulgaris, Lmk., in herring nets in the summer, Laggan Bay.
**Eledone cirrosa* (Lmk.), young, taken in herring nets in Laggan Bay in December.

CRUSTACEA.

Podopthalmata.

Brachyura.

Stenorhynchus tenuirostris, not common in Lochfyne.
**Inachus dorsettensis*, frequent in 10 to 20 fathoms, Lochfyne.
**Hyas araneus*, common between tide marks.
* „ *coarctatus*, common in the off-shore waters of Lochfyne, but not so abundant as on some parts of the east coast of Scotland.
**Cancer pagurus*, frequent on the rocky shores of Lochfyne, but not large so far as our observation goes. There is no systematic crab fishery.
**Carcinus mænas*, common.
Portunus puber, frequent in 10 to 15 fathoms or more in Lochfyne.
„ *depurator*, frequent.
* „ *marmoreus*, frequent.
* „ *pusillus*, frequent.
Ebalia bryerii, Sunidale Bay, 20 fathoms.

Anomoura.

Lithodes maia, common in Lochfyne, mostly medium size.
**Pagurus bernhardus*, common.
„ *prideauxii*, common. Often has the beautiful anemone Peachia attached to it.
* „ *ferrugineus* (Norm.), East Loch Tarbert.
„ *lævis*, frequent.
**Porcellana longicornis*, not very plentiful, between tide marks.
**Galathea squamifera*, common.
„ *intermedia* (Lill.), East Loch Tarbert and Buck Bay.

Macrura.

Palinurus vulgaris, a single specimen taken in herring nets by Ardrishaig fishermen in the spring.
**Calocaris M'Andreæ*, occurs sparingly in the deeper portions of Lochfyne, 60 to 90 fathoms.
Homarus vulgaris, generally distributed. There is a small summer fishery in Buck Bay, which is carried on by Ardrossan fishermen.
**Crangon vulgaris*, by no means plentiful.
" *spinosus*, rare.
* " *Almani*, frequent in the off-shore water.
Crangon neglectus (Sars), East Loch Tarbert and at Barmore, new to Britain.
**Virbius (Hippolyte) varians*, Zostera bed, East Loch Tarbert, abundant.
" *fasciger* (Gosse.), East Loch Tarbert.
Hippolyte pandaliformis, East Loch Tarbert.
" *securifrons* (Norm.), common in 20 to 40 fathoms, Lochfyne.
Pandalus annulicornis, common.
" *brevirostris* (Rathke), East Loch Tarbert.

Schizopoda.

**Boreophausia Raschii* (G. O. Sars), Lochfyne.
**Nyctiphanes norvegica* (M. Sars), Lochfyne; also found in stomachs of herring and *Acanthias*.
Erythrops pygmæa (Sars), Barmore, and East Loch Tarbert, new to Britain.
Mysidopsis gibbosa (G. O. Sars), East Loch Tarbert, new to Britain.
" *angusta* (G. O. Sars), in 4 fathoms, Barmore.
Leptomysis linguara (G .O. Sars), East Loch Tarbert.
Mysis chamæleon (J. V. Thomps.), Zostera bed, East Loch Tarbert.
" *inermis* (Rathke), Zostera bed, East Loch Tarbert.
" *arenosa* (G. O. Sars), Zostera bed, East Loch Tarbert.
" *lamornæ* (Couch.), East Loch Tarbert.
**Siriella Clausii* (G. O. Sars), East Loch Tarbert.
" *Brooki* (Norm.), East Loch Tarbert.
" *armata* (M. Edw.), East Loch Tarbert.

Cumacea.

Vaunthompsonia cristata (Ball.), East Loch Tarbert.
Lamprops uniplicata, (?) East Loch Tarbert.
Hemilamprops fasciata (G. O. Sars), at low water, East Loch Tarbert.
Pseudocuma cercaria (Van Ben.), East Loch Tarbert.
Diastylis rugosa (Sars), East Loch Tarbert.

Copepoda.

See separate list given by Mr Calderwood.

Ostracoda.

Pontocypris mytiloides (Norm.), East Loch Tarbert.
" *trigonella* (Sars), East Loch Tarbert.
Cythere lutea (Müll.), East Loch Tarbert.

Cythere viridis (Müll.), East Loch Tarbert.
,, *pellucida* (Baird), East Loch Tarbert.
,, *crispata* (Brady), East Loch Tarbert.
,, *albo-maculata* (Baird), East Loch Tarbert.
,, *convexa* (Baird), East Loch Tarbert.
,, *tuberculata* (Sars), East Loch Tarbert.
,, *concinna* (Jones), East Loch Tarbert.
,, *angulata* (Sars), East Loch Tarbert.
,, *villosa* (Sars), East Loch Tarbert.
,, *antiquata* (Baird), Lochfyne.
,, *Jonesii* (Baird), Lochfyne.
Cytheridea papillosa (Bosq.), Lochfyne.
,, *punctillata* (Brady), Lochfyne.
Encythere argus (Sars), Lochfyne.
Krithe Bartonensis (Jones), East Loch Tarbert.
Loxoconcha impressa (Baird), East Loch Tarbert.
,, *granulata* (Sars), East Loch Tarbert.
,, *tamarindus* (Jones), East Loch Tarbert.
,, *multiflora* (Norm.), East Loch Tarbert.
Xestoleberis aurantia (Baird), East Loch Tarbert.
Cytherura nigrescens (Baird), East Loch Tarbert.
,, *angulata* (Brady) East Loch Tarbert.
,, *striata* (Sars), East Loch Tarbert.
,, *undata* (Sars), East Loch Tarbert.
,, *gibba* (Müll.), East Loch Tarbert.
,, *cornuta* (Brady), East Loch Tarbert.
,, *cellulosa* (Norm.), East Loch Tarbert.
,, *flavescens* (Brady), East Loch Tarbert.
Cytheropteron latissimum (Norm.), East Loch Tarbert.
,, *arcuatum*, (B. C. and R.), East Loch Tarbert.
,, *nodosum* (Brady), East Loch Tarbert.
,, *angulatum* (B. and R.), East Loch Tarbert.
Bythocythere simplex (Norm.), East Loch Tarbert.
,, *turgida* (Sars), Furlong Bay.
Pseudocythere caudata (Sars), Lochfyne.
Sclerochilus contortus (Norm.), Lochfyne.
Xiphichilus tenuissima (Norm.), Lochfyne.
Paradoxostoma variabile (Baird), East Loch Tarbert.
,, *pulchellum* (Sars), Furlong Bay.
Philomedes interpuncta (Baird), East Loch Tarbert.
Asterope Mariæ (Baird), East Loch Tarbert).
,, *teres* (Norm.), East Loch Tarbert.
Polycope orbicularis (Sars), East Loch Tarbert.

Cirripedia.

Balanus balanoides, L., on stones and shells, East Loch Tarbert.
,, *crenatus* (Brug.), on stones and shells, East Loch Tarbert.
Verruca Stromia (Müll.), on stones and shells, East Loch Tarbert.

ECHINODERMATA.

Crinoidea.

Antedon rosaceus, common near the east shore of Lochfyne.

Ophiuroidea.

**Amphiura filiformis* (Müll.), off Buck Island.
,, *elegans* (Leach), frequent between tide marks.
Ophiactis Ballii (Thomp.)? Zostera bed, East Loch Tarbert.
**Ophiocoma nigra*, (O. F. M.), very abundant up to 15 to 20 fathoms.
**Ophioglypha albida* (Forb.), common.
,, *lacertosa* (Linck.), frequent, East Loch Tarbert.
Ophiopholis aculeata (O. F. M.), common near east shore of Lochfyne.
**Ophiothrix rosula* (Linck.), common, particularly near the east shore of Lochfyne

Asteroidea.

Asterias rubens (L.), abundant.
,, *violacea* (O. F. M.), with the preceding.
,, *glacialis* (L.), frequent in 20 to 30 fathoms in Lochfyne, some of large size.
Solaster papposus (L.), frequent in Lochfyne, smaller specimens between tide marks.
,, *endeca*, L., frequent some distance from shore, and also occurs at low water.
**Cribrella oculata* (Linck.), East Loch Tarbert.
* ,, *rosea* (Müll), East Loch Tarbert.
Hippasteria plana (Linck.), frequent in shallow water.
Luidia savignyi (Aud.), Sunidale Bay, 20 fathoms.

Echinoidea.

Echinus esculentus (Penn.), very abundant in some parts of Lochfyne, particularly in the Channel between Skate Island and the Mainland.
* ,, *miliaris* (L.), between tide marks, East Loch Tarbert.
**Echinocyamus pusillus* (Müll.), Sunidale Bay.
**Spatangus purpureus* (Leske), Sunidale Bay.
**Echinocardium cordatum* (Penn.), very abundant in the sand at White Shore Bay, East Loch Tarbert.

Holothuroidea.

Several species which are not yet identified.

FORAMINIFERA.

Cornuspira foliacea (Phil.), East Loch Tarbert.
Biloculina ringens (Lam.), Lochfyne, near Tarbert.
,, *depressa* (d'Orb.), East Loch Tarbert.
Triloculina trigonula (Lam.), Lochfyne, near Tarbert.
,, *tricarinata* (d'Orb.), Lochfyne, near Tarbert.
Miliolina seminulum (L.) East Loch Tarbert.
,, *subrotunda* (Mont.), East Loch Tarbert.
,, *secans* (d'Orb.), East Loch Tarbert.
,, *Ferussacii* (d'Orb.), East Loch Tarbert.
,, *agglutinans* (d'Orb.), East Loch Tarbert.
Spiroloculina limbata (d'Orb.), Lochfyne.
,, *canaliculata* (d'Orb.), Lochfyne.

Trochammina, sp., East Loch Tarbert.
Lagena sulcata (W. and J.), East Loch Tarbart.
,, *lævis* (Mont.), Lochfyne.
,, *gracillima* (Sagz.), Lochfyne.
,, *globosa* (Mont.), Lochfyne.
,, *striata* (d'Orb.), Lochfyne.
,, *marginata* (W. and J.), East Loch Tarbert.
,, *melo* (d'Orb.), Lochfyne.
,, *squamosa* (Mont.), East Loch Tarbert.
,, *hexagona* (Will.), Lochfyne.
,, *Jeffreysii* (Brady), Lochfyne and East Loch Tarbert.
Nodosaria scalaris (Batsch.) Lochfyne, frequent.
Polymorphina lactea (W. and J.), East Loch Tarbert.
,, *tubulosa* (d'Orb.), Lochfyne.
Dentalina communis (d'Orb.), Lochfyne.
Orbulina universa (d'Orb.), East Loch Tarbert.
Textularia sagittula (Defrance), East Loch Tarbert.
Bulimina marginata (d'Orb.), East Loch Tarbert.
Discorbina rosacea (d'Orb.), East Loch Tarbert.
Truncatulina lobatula (Walker), East Loch Tarbert.
Rotalia Beccarii, L., East Loch Tarbert, common.
,, *nitida* (Will.), East Loch Tarbert, rare.
Patellina corrugata (Will.), Lochfyne.
Polystomella crispa (L.), East Loch Tarbert, common.
,, *striato-punctata* (F. and M.), East Loch Tarbert, common.
Nonionina asterizans (F. and M.), East Loch Tarbert, common.
,, *depressula* (W. and J.), East Loch Tarbert, common.
Planorbulina Mediterranensis (d'Orb.), East Loch Tarbert, common.

APPENDIX F.—No. XVIII.

THE SPAWNING PERIOD of the BRITISH FOOD-FISHES.

By George Brook, F.L.S.

The present list has been chiefly prepared for the information of the various officers of the Board. A large amount of the information has been taken from Day's *British Fishes.* Use has also been made of the publications of the American and German Fish Commissions, Costa's *Fishes of the Bay of Naples,* and Schmidtlein's lists of the spawning period of the fishes and other forms in the Bay of Naples, published in the *Journal of the Naples Zoological Station.* The more detailed accounts given for many of the commoner food-fishes have been supplied by the Fishery officers of the various districts. In these there are evidently many errors; for instance, it is manifestly impossible for turbot to spawn in May, June, and July off Aberdeen, and not until September and October off Peterhead! However, each officer has supplied the information asked for from the best available sources, and it would be premature to attempt to decide such important points on necessarily imperfect evidence. There

is evidently a great want of systematic observations, and these can only be carried on efficiently with some basis to work upon; the present list has been compiled in order to form such a basis. It is hoped that every item in it may be checked repeatedly, and that in course of time the many inaccuracies which doubtless exist may be duly rectified. Notes have been added on those species of fish eggs which are known to float; most of these I have been able to verify. The number of species of floating eggs will, without doubt, be very much increased as our investigations are pushed further.

The spawning period of any given species may vary within definite limits in different localities, and even in the same district a considerable variation may be observed between one year and another. The age of the individual, the supply and nature of the food, the temperature of the water, the general severity or mildness of the weather for some time previously, and many other points have to be taken into consideration. Again, in some species, as, for example, the herring, the spawning period is of short duration so far as the individual is concerned. The majority of the eggs are ripe about the same time, and are shed in a comparatively short period. On the other hand, in such forms as the cod, the period during which the eggs are shed by one individual is very much longer, as only a few eggs are ripe at a time. This is a point which, when carefully noted, may be expected to give interesting results.

The information given in the present list concerning the spawning period of the Salmonidæ is simply copied from Day's *British Fishes*. As my friend Dr Day points out, this part of the problem is particularly difficult, on account of uncertainty existing as to what should be regarded as a species, and what as a variety. Until this point is settled any statistics would be imperfect and misleading. It has also been shown that age, race, hybridism, and many other factors have to be taken into account. Dr Day is collecting information on this subject, so that until the publication of his results, it appears better to let the matter remain in *statu quo*.

THE SPAWNING PERIOD OF FOOD-FISHES.

(*Dates already verified are in heavier type.*)

TELEOSTEI.

Latin Name.	English Name.	Spawning period.	Remarks.
PERCIDÆ.			
Perca fluviatilis.	Perch.	March to May. **Early May** in Loch Fadd, Bute.	**May** and **early June,** in confinement (Roth. Aq.).
Labrax lupus.	Bass.	Summer months, July and Aug. (Couch); also Feb. and March (Naples).	Said to deposit its ova twice a year on the Continent.
Acerina vulgaris.	Ruff.	March and April (Day).	
Serranus cabrilla.	Comber.	End of summer, or Aug. to Sept. (Day).	
Serranus gigas.	Dusky perch.	April and May; March, Mediterranean (Costa).	Chiefly found in warmer climates.
Polyprion cernium.	Stone basse.	Summer in Mediterranean (Risso).	
Dentex vulgaris.	Dentex.	Feb. and March, Naples (Costa).	
MULLIDÆ.			
Mullus barbatus.	Red mullet.		
Mullus surmuletus.	Surmullet.	(Variety of *Mullus barbatus, cf.* Day's *British Fishes,* vol. i. p. 22.) July to Sept., on south coast (Day). May, both varieties (Naples).	
SPARIDÆ.			
Cantharus lineatus.	Old wife.		
Box vulgaris.	Bogue, ox-eye.	...	Said to spawn twice a year in warmer climates.
Pagrus auratus.	Gilt head.	Spawns in summer in Mediterranean (Risso).	
Pagellus centrodontus.	Sea bream.	Winter months (Day).	
SCORPÆNIDÆ.			
Sebastes norvegicus.	Bergylt, Norway haddock or carp.		
COTTIDÆ.			
Cottus bubalis.	Father lasher.	Dec. and Jan. (Day); **April** and **May** (Lochfyne).	
Trigla lineata.	Streaked gurnard.		
Trigla cuculus.	Red gurnard.	April to June (Couch).	
Trigla hirundo.	Tub-fish.	Jan. to June (Couch).	
Trigla gurnardus.	Gray gurnard.	Dec. and Jan.; June and July.	Eggs float, *cf* Sars, *Ann. and Mag. Nat. Hist.*, ser. iv. 1868.
Trigla lyra.	Piper.		
Trigla obscura.	Lanthorn gurnard.	Midsummer? (Day).	
TRACHINIDÆ.			
Trachinus draco.	Greater weever.	June on the Continent.	
Trachinus vipera.	Lesser weever.	**April, May,** and early **June** (Yorkshire coast).	Eggs float.

Latin Name.	English Name.	Spawning period.	Remarks.
SCOMBRIDÆ.			
Scomber scomber.	Mackerel.	May and June (Day); June and July (F. O., Peterhead and Aberdeen); May (Campbeltown).	Eggs float. A few ripe fish in Lochfyne in **July** and **August.**
Scomber colias.	Spanish mackerel.	...	Eggs float.
Orcynus thynnus.	Short-finned tunny.	June in Sicily.	
Orcynus germo.	Long-finned tunny.		
Thynnus pelamys.	Bonito.		Couch found roe well developed in July.
Pelamys sarda.	Belted bonito.		
Auxis rochei.	Plain bonito.	August (Day).	
CORYPHÆNIDÆ.			
Brama raii.	Ray's bream.	Summer (Risso).	
Lampris luna.	Opah.		
Luvarus imperialis.	...	...	Ova well developed in summer (Risso).
CARANGIDÆ.			
Caranx trachurus.	Scad, horse-mackerel.	June to Aug. (Day).	Spring in Mediterranean (Risso).
Lichia glauca.	...	Summer (Risso).	
Capros aper.	Boar fish.	May to July (Dunn); April (Risso).	Eggs float (Dunn).
CYTTIDÆ.			
Zeus faber.	John Dorey.	Winter? (Dunn).	Eggs float (Agassiz).
XIPHIIDÆ.			
Xiphias gladius.	Sword fish.		
SCIÆNIDÆ.			
Sciœna aquila.			
Trachiurus lepturus.	Hair tail.		
GOBIIDÆ.			The Gobies are too small to be of much use as food, but a few are often mixed in consignments of whitebait. *Gobius Ruthensparri* spawns from **April** to **July** (Lochfyne).
Aphia pellucida.	...	June to August; Christiania Fjord (Collett).	
BLENNIIDÆ.			
Anarrhichus lupus.	Wolf fish.	May and June (Pennant); May and June (F. O., Montrose); winter (Willoghby).	
Zoarces viviparus.	Viviparous blenny.	Throughout the year (Nilsson); St Andrews, advanced embryos **Nov.** to **Jan.** (M'Intosh).	
TRACHYPTERIDÆ.			
Trachypterus arcticus.	Deal-fish.		
ATHERINIDÆ.			
Atherina presbyter.	Sand smelt.	July (Day); June to Aug. (Couch); spring in Dingle Harbour (Andrews).	

Latin Name.	English Name.	Spawning period.	Remarks.
MUGILIDÆ.			
Mugil capito.	Grey mullet.	Winter? (Day).	
Mugil chelo.	Lesser grey mullet.		
LABRIDÆ.			
Labrus maculatus.	Ballan-wrasse.	June at Galway; May to July, south coast (Day).	The eggs of several species of Labridæ are known to float. Those of *Ctenolabrus rupestris* do so, and are ripe in **June** in Lochfyne.
GADIDÆ.			
Gadus morhua.	Cod.	Jan. to April (Day).	Eggs float. **March** and **April.** in confinement (Rothesay Aquarium).
		EAST COAST. *Berwick,* March and April. *Anstruther,* March. *Montrose,* middle Feb. to end of March. *Stonehaven,* Feb. March, April, and May. *Aberdeen,* March, April, and May. *Peterhead,* Feb. and March. *Fraserburgh,* Feb. and March. *Buckie,* March. *Helmsdale,* March and April. *Wick,* Feb. and March. *Lerwick,* Feb. and March.	A few do not spawn until April and May.
		WEST COAST. *Girvan,* **March** and **April.** *Ardrishaig,* Feb. and March. *Campbeltown,* **Mar.** and **April.** *Stornoway,* March and April.	The majority of those caught in the Sound of Gigha spawn a little earlier.
Gadus æglefinus.	Haddock.	EAST COAST. *Berwick,* Feb. and March. *Anstruther,* Feb. to middle of March. *Montrose,* Feb. and March. *Stonehaven,* Feb. and March to middle of April. *Aberdeen,* Feb., March, and April.	Eggs float. A specimen was obtained by F. O., 5/6/85, containing ripe roe.
		Peterhead, March and April. *Fraserburgh,* Feb. and March. *Buckie,* Feb.	

Latin Name.	English Name.	Spawning period.	Remarks.
GADIDÆ—*cont.* *Gadus æglefinus.*	Haddock.	EAST COAST. *Helmsdale*, March. *Wick*, Feb. and March. *Lerwick*, Jan. and Feb. WEST COAST. *Girvan*, Feb. *Ardrishaig*, Feb. and March. *Campbeltown*, Mar. and April. *Stornoway*, end March and early April.	
Gadus luscus.	Whiting pout.	End of winter in Cornwall (Day). **Early summer** at *St Andrews.*	
Gadus merlangus.	Whiting.	March (Day). EAST COAST. *Berwick*, March, April, and May. *Anstruther*, Feb.? and March. *Montrose*, April and May. *Stonehaven*, Jan., Feb., and March. *Aberdeen*, thought to spawn in Jan. and Feb., and in Sept. and Oct. *Peterhead*, March and April. *Fraserburgh*, April. *Buckie*, June? *Wick*, probably Jan. and Feb. *Lerwick*, Jan. and Feb. WEST COAST. *Girvan*, Feb. *Ardrishaig*, Feb. and March. *Campbeltown*, Mar. and April. *Stornoway*, March and April.	Eggs float. **May** and **early June** in confinement (Rothesay Aquarium). Spawns off the coast in deep water in large numbers.
Gadus poutassou.	...	Spring at Nice.	
Gadus virens.	Coalfish, saithe.	Nov. and Dec. in America; spring in Cornwall (Day). EAST COAST. *Berwick*, April and May. *Anstruther*, March? *Montrose*, probably Jan. and Feb. *Stonehaven*, Jan. and Feb.? *Aberdeen*, Jan., Feb., and March. *Peterhead*, Feb. and March.	Few are caught having milt or roe.

Latin Name.	English Name.	Spawning period.	Remarks.
GADIDÆ—*cont.* *Gadus virens.*	Coalfish, saithe.	EAST COAST. *Fraserburgh*, Feb. and March. *Buckie?* *Helmsdale*, March. *Wick*, Dec.? and Jan. *Lerwick*, March and April.	Few landed.
		WEST COAST. *Girvan*, March and April. *Ardrishaig*, Feb. and March. *Campbeltown*, April and May. *Stornoway*, April and May.	
Gadus pollachius.	Pollack, lythe.	End and beginning of year (Day).	
		EAST COAST. *Berwick*, April and May. *Montrose*, supposed to be Feb. and March. *Stonehaven*, March and April. *Aberdeen*, Aug.? *Peterhead*, Feb. and March. *Fraserburgh*, March. *Wick*, Dec.?	Few caught.
		WEST COAST. *Campbeltown*, April and May. *Stornoway*, end of March and early April.	
Merluccius vulgaris.	Hake.	Spring, but may be delayed in cold seasons (Day).	Aug. in 1837 Cornish coast (Couch).
		EAST COAST. *Montrose*, Aug. and Sept. *Aberdeen*, Aug. and Sept. *Peterhead* June and July. *Fraserburgh*, June and July. *Wick*, June and July.	
		WEST COAST. *Campbeltown*, Aug. *Stornoway*, March and April.	
Phycis blennoides.	Greater forkbeard.		
Molva vulgaris.	Ling.	Spring to June (Day).	
		EAST COAST. *Berwick*, April and May. *Anstruther*, April and May.	

Latin Name.	English Name.	Spawning period.	Remarks.
GADIDÆ—*cont.*		EAST COAST.	
Molva vulgaris.	Ling.	*Montrose*, May and June.	
		Stonehaven, May and June.	
		Aberdeen, May and June.	
		Peterhead, May and June.	
		Fraserburgh, May.	
		Buckie, June and July.	Full of spawn in early part of June.
		Helmsdale, June.	
		Wick April, May, and June.	
		Lerwick, April and May.	
		WEST COAST.	
		Girvan, March and April.	
		Ardrishaig ?	Few landed.
		Campbeltown, March and April.	
		Stornoway, May.	
Lota vulgaris.	Burbot, eelpout.	Dec. to March (Day).	
Motella mustela.	Five-bearded rockling.	**May** and **June.** (Yorkshire).	Eggs float.
Brosmius brosme.	Torsk.	April and May in northern seas (Day); March (F. O., Wick); May and June (F. O., Peterhead); May and June (F. O., Lerwick).	
OPHIDIIDÆ.			
Ammodytes lanceolatus.	Larger launce, sand eel.	Autumn and winter (Day).	
Ammodytes tobianus.	Lesser launce.	Winter (Day).	
Ammodytes cicerellus.	Smooth sand launce.		
PLEURONECTIDÆ.			
Hippoglossus vulgaris.	Holibut.	April (Couch).	Eggs float. Ripe ova from Berwick in **May.**
		EAST COAST.	
		Berwick, April and May.	
		Anstruther ?	
		Montrose, May and June.	
		Stonehaven, probably Aug. and Sept.	Carry roe in June or July.
		Aberdeen, July and Aug.	
		Peterhead, Sept. and Oct.	
		Fraserburgh, June and July.	
		Buckie ?	Few landed; carry roe in Feb.
		Helmsdale, April.	
		Wick, Feb. and March.	
		Lerwick, May and June.	

Latin Name.	English Name.	Spawning period.	Remarks.
PLEURONECTIDÆ—*continued.*			
Hippoglossus vulgaris.	Holibut.	WEST COAST. *Girvan,* May and June. *Ardrishaig ?* *Campbeltown,* March *Stornoway,* May.	 Few landed.
Hippoglossoides limandoides.	Long rough dab.	May and June (Couch); possibly March and April (F. O., Montrose).	Eggs float.
Rhombus maximus.	Turbot.	Summer (Day). EAST COAST. *Berwick,* April and May. *Anstruther ?* *Montrose,* May and June. *Stonehaven,* June and July. *Aberdeen,* May, June, and July. *Peterhead,* Sept. and Oct. *Fraserburgh,* June and July. *Buckie ?* *Wick,* Feb. and March. *Lerwick,* May and June. WEST COAST. *Girvan,* May and June. *Ardrishaig ?* *Campbeltown,* Mar. *Stornoway,* May.	Buckie: Carry roe in Feb. Ardrishaig: Few landed. Campbeltown: Has been seen with spawn in Sept.
Rhombus lævis.	Brill.	Spring (Parnell). EAST COAST. *Berwick,* March, April, and May. *Montrose,* supposed to be May and June. *Aberdeen,* May, June, and July.	 Berwick: Few landed. Montrose: Few landed.
Zeugopterus unimaculatus.		**June,** Lochfyne.	Eggs float.
Zeugopterus punctatus.	Topknot.	Summer and autumn (Day).	
Arnoglossus megastoma.		Oct. (Thompson).	
Pleuronectes platessa.	Plaice.	Feb. and Mar. (Day). EAST COAST. *Berwick,* April and May. *Montrose,* March and April. *Aberdeen,* Feb. and March.	Eggs float.

Latin Name.	English Name.	Spawning period.	Remarks.
PLEURONECTIDÆ—*continued.* *Pleuronectes platessa.*	Plaice.	EAST COAST. *Peterhead*, Aug. *Fraserburgh*, Aug. *Rothesay*, March, **April**, and **May.**	
Pleuronectes microcephalus.	Smooth dab.	May and June (Day). **April** and **May** at *Rothesay.*	
Pleuronectes cynoglossus.	Pole dab.	May and June (Day).	
Pleuronectes limanda.	Common dab.	April to June (Day).	
		EAST COAST. *Berwick*, March, April, and May.	
		Anstruther ?	Few landed.
		Montrose, supposed to be Dec. and Jan.	
		Stonehaven, Feb. ?	Few landed.
		Aberdeen, June and July.	
		Peterhead, Sept. and Oct.	
		Fraserburgh, April and May.	
		Buckie ?	Very few landed.
		Wick, Feb. and March.	
		WEST COAST. *Girvan*, May and June. *Campbeltown*, Jan. and Feb.	
Pleuronectes flesus.	Flounder.	Feb. to April (Day).	
		EAST COAST. *Berwick*, March, April, and May. *Stonehaven*, Feb. *Aberdeen*, Jan. and Feb. *Peterhead*, Sept. and Oct.	
		Buckie.	Few landed.
		Helmsdale, June. *Wick*, Feb. and March.	
		WEST COAST. *Girvan*, May and June. *Rothesay*, **April** and **May.** *Campbeltown*, Jan. and Feb. *Stornoway*, March and April.	
Solea vulgaris.	Sole	Spring (Day).	
		EAST COAST. *Berwick*, March, April, and May.	
		Aberdeen, probably May, June, and July.	Very few landed.

Latin Name.	English Name.	Spawning period.	Remarks.
PLEURONECTIDÆ—*continued.*			
Solea vulgaris.	Sole.	EAST COAST. *Peterhead*, Sept. and Oct. *Fraserburgh*, May. *Wick*, Feb. and March. WEST COAST. *Girvan*, May and June. *Campbeltown*, Jan. and Feb.	
Solea lascaris.			
Solea variegata.			
SALMONIDÆ.			
Salmo salar.	Salmon.	Nov. to Jan.	
Salmo trutta.	Salmon trout, sea trout.	Oct. to Dec.	
Salmo levenensis.	Loch Leven trout.	Oct. to Dec.	
Salmo fario.		Sept. to March.	
Salmo alpinus.		Nov. to March.	
Salmo fontinalis.		Oct. to March.	Has been naturalised in many parts of the country.
Osmerus eperlanus.	...	March and April (Day).	
Coregonus oxyrhynchus.			
Coregonus clupeoides.	...	Dec. (Pennant).	
Coregonus vandesius.	Vendace.	Nov. (Day).	
Coregonus pollan.	Pollan.	Nov. and Dec. (Day).	
Thymallus vulgaris.	Grayling.	April and May (Day).	
ESOCIDÆ.			
Esox lucius.	Pike.	Feb. to April (Day).	**End** of **May,** in confinement (Rothesay Aquarium).
SCOMBRESOCIDÆ.			
Belone vulgaris.	Garfish.	May to June, on south coast (Day).	
Scomberesox saurus.	Skipper.		
CYPRINIDÆ.			
Cyprinus carpio.	Carp.	May and June (Day).	
Carassius vulgaris.	Crucian carp.	April to June (Day).	
Barbus vulgaris.	Barbel.	May and June (Day).	
Gobio fluviatilis.	Gudgeon.	April to June (Day).	
Leuciscus rutilis.	Roach.	June (Day).	
Leuciscus cephalus.	Chub.	May (Day).	
Leuciscus vulgaris.	Dace.	June (Day).	
Leuciscus erythrophthalmus.	Rudd.	April and May (Day).	
Leuciscus phoxinus.	Minnow.	May and June (Day).	
Tinca vulgaris.	Tench.	May to July (Day).	
Abramis brama.	Bream.	May (Day).	
Alburnus lucidus.	Bleak.	May to July (Day).	
Cobitus tænia.	Spined loach.	March and April (in France).	
Nemacheilus barbatula.	Loach.	March and April (Day).	
CLUPEIDÆ.			
Engraulis encrasicholus.	Anchovy.	Sept. to Dec. (Day); May to July (Mediterranean).	

Latin Name.	English Name.	Spawning period.	Remarks.
CLUPEIDÆ—*cont.*			
Clupea harengus.	Herring.	EAST COAST. *Berwick*, **Aug., Sept.,** Feb., and **March.** *Anstruther*, Jan. and Feb., **April.** and **May;** also **Aug.** *Montrose*, **Aug.** and **Sept.** *Stonehaven*, Jan., Feb., and March; **Aug., Sept.** and Oct. *Aberdeen*, Feb. and March; July, **Aug.** and **Sept.** *Peterhead*, Feb. and March, **Aug.** and **Sept.** *Fraserburgh*, March, **Aug.,** and **Sept.** *Buckie*, Jan., Feb., March, and July, **Aug., Sept.** *Helmsdale*, Feb. and **Aug.** *Wick*, Feb. and March; **Aug.** and **Sept.** *Lerwick*, Feb. and March; **Aug.** and **Sept.**	Carries 44,000–49,000 ova. Carries, 50,000 to 107,000 ova.
		WEST COAST. *Girvan*, **Feb.** and **March.** *Ardrishaig*, **Aug.** and **Sept.** *Campbeltown*, **April,** July, **Aug., Sept., Oct.,** Nov., and Dec. *Stornoway*, Feb., **March,** and July.	Used to spawn in large numbers in upper part of Lochfyne, but now scarcely any herring spawn in the district.
Clupea pulchardus.	Pilchard.	May and June; also Dec. (Dunn).	
Clupea sprattus.	Sprat.	Moray Firth and Firth of Forth, May and June (Mathews); Cornwall, Dec. and Jan. (Day); Firth of Tay, Dec. and Jan.? (Sim); June and July (F. O., Stonehaven).	
Clupea alosa.	Allis shad.	May and June (Day).	
Clupea finta.	Twait shad.	June and July (Day).	
MURÆNIDÆ.			
Anguilla vulgaris.	Eel.	**June** at *St Andrews.*	
Conger vulgaris.	Conger eel.	Dec. and Jan. (Yarrell).	
Murœna helena.			
GYMNODOTES.			
Orthagoriscus mola.	Sun fish.		

GANOIDEI.

Latin Name.	English Name.	Spawning period.	Remarks.
ACIPENSERIDÆ.			
Acipenser sturio.	Sturgeon.	Winter and early spring in Northern Europe; April and May (Naples).	

ELASMOBRANCHII.

Latin Name.	English Name.	Spawning period.	Remarks.
CARCHARIIDÆ.			
Mustelus vulgaris.	Smooth hound.	Nov. (Couch); June (Naples).	Eaten in Hebrides.
LAMNIDÆ.			
Selache maxima.	Basking shark.	...	Eaten in Hebrides.
SCYLLIIDÆ.			
Scyllium canicula.	Rough hound.	April.	
SPINACIDÆ.			
Acanthias vulgaris.	Picked dog-fish.	Summer and autumn; throughout the year? (Dunn).	
RAIIDÆ.			
Raia batis.	Skate.	March and April to Sept. or Oct.	
Raia alba.	Sharp-nosed ray.		
Raia clavata.	Thornback ray.	May to July and August.	
Raia maculata.	Spotted ray.	June (Brighton Aquarium).	

CYCLOSTOMATA.

Latin Name.	English Name.	Spawning period.	Remarks.
PETROMYZONTIDÆ.			
Petromyzon marinus.	Sea lamprey.	April and May (in south); June (Scotland).	
Petromyzon fluviatilis.	Lampern.	April to June (Day).	

APPENDIX F.—No. XIX.

THE SOLWAY FISHING. By Peter Wilson, Fishery Officer, Girvan.

The methods of fishing and the description of fish caught are limited to that estuary. The readers of 'Red Gauntlet' will be familiar with the dark rows of stake-nets, the long muddy fore-shores, and the flounder-nets of the coast fishermen, worked by the ebb and flow of the tide, and though there is no longer the swift horseman plashing through the pools and spearing the salmon, the external aspects of matters is not greatly changed. There is the solitary fisherman, with stick in hand and wicker basket across his back, plodding to his nets by night or by day as their dark tops become visible by the swift receding tide, and doing as his fathers did half a century ago. The principal sea fish caught on the estuary of the Solway are flounders, shrimps, and cockles. Mussels seed very freely, but the shifting sand banks speedily destroy them, and hence the mussel banks serve chiefly as a feeding bed for flounders. The shrimp fishing is the most extensive and valuable in Scotland. From the town of Annan about forty small vessels of about 4 tons each and cutter rigged are engaged in the shrimp fishing in its season. They work with a small meshed trawl-net, and are manned by two men in each. The tide is everything in the Solway, and there it is hopeless to strive against the stream. Unloosing their moorings at the water foot, Annan, with the first of the ebb tide, the net is cast, and the little vessel may be seen driving along the channel, and outwards to a distance of eight or ten miles. The returning tide brings them back over the same ground, and when off the village of Powfoot, about three miles from Annan, a thin cloud of steam may be seen rising from the vessel. This indicates that the net has been finally drawn. The shrimps are put alive into a pot of boiling water and cooked, a liberal supply of salt being used in the process. Shrimps are largely supplied to beer shops in most of the large towns in England, but are not extensively used in Scotland. The catch of shrimps at Annan in 1885 was over 2000 cwts., valued at £6000. The same vessels also engage in the flounder fishing, for which a beam trawl, with a wider meshed net is used. In the months of January and February the fishermen take to cockle fishing, and about 1200 cwts. have in the present season been landed, valued at £250. The shore fishermen work a kind of small stake-net, with covered pockets, chambers or paidles placed in the angles of the arms, which are only open to the out-going tide, the flounders which may have gone on to the banks to feed dropping into the pockets with the ebb. This method of fishing has been long in use in the Solway, and has been the cause of much contention and expensive litigation between the proprietors of the salmon fisheries and the shore fishermen. The draw-net, as a more successful method, is now coming into use, and about the shoal banks of the Solway is likely to become a more profitable method, and will in time supersede the small stake-nets which have for many years been set on the edge of the low-water mark. From its fast-flowing tide, and the drainage of so many rivers and streams falling into the Solway, it will always remain a rich breeding place for fish, especially flat fish, and such as prefer the hard food found upon its scars.

APPENDIX F.—No. XX.

SOME ECONOMIC PRODUCTS FROM FISH AND CORRESPONDING VEGETABLE PRODUCTS.

By WILLIAM STIRLING, M.D., Sc.D., Brackenbury Professor of Physiology in Owens' College and Victoria University, Manchester; formerly Professor of Institutes of Medicine in the University of Aberdeen.

PUBLIC attention has been thoroughly aroused to the question of social economics involved in our food supply, whether it be derived from the vegetable or animal kingdom. The immense importance of the fishing industry is now well understood, and while what concerns the capture of fish has been matter of anxious inquiry, and has received much attention from the legislature, other problems connected with the utilisation of the 'harvest of the sea' have not received so much attention as they demand. The whole question of the conveyance of fresh fish from the often remote districts where they are captured to the great dense centres of population requires to be thoroughly gone into, so that facilities may be offered—by rail or sea, or both—for the speedy distribution of the spoil. Professor J. C. Ewart, in some articles recently contributed to the *Scotsman*, has directed the attention of the public to the importance of preserving fish in such a state of freshness that they can be transported within a reasonable period to any part of the kingdom. The ordinary methods in everyday use—such as salting, smoking, and other processes—are well-known and understood.

There are other aspects, however, in which the question of our fish supply, in relation to social economics, may be viewed. A fish is a composite creature, and from it many products are obtainable other than those directly useful as food, and which have a direct and even high marketable value. The question arises therefore whether it is not possible so to utilise the supply of fish at our great fishing ports as to obtain the best possible value for the products. Everyone is familiar with the fact as regards cattle that, when it is not possible—or at least it is not advantageous from a commercial point of view—to transport them from the great cattle raising districts of South America, or elsewhere, various methods of utilisation are employed *on the spot*, whereby the meat is either boiled and sealed up in tins, or an extract is made. The latter is at least a portable article, and has a certain dietetic value.

Baron von Liebig suggested the idea—and had it carried into practice of making what he called an 'Extract of Meat,'—which bears his name and is now well-known as an article of commerce. It is right, however, that these extracts should be estimated at their true dietetic value. In an extract of meat, those substances soluble in water are extracted from the meat, and all the proteids (or albumins) are afterwards coagulated by the aid of heat, and it may be by the addition of dilute acid. The fluid, after the coagulated albumin has been skimmed off, consists of the extractives and the salts soluble in water. This is evaporated down until a thick syrupy brownish looking semi-fluid substance is obtained, which is the extract. It contains no proteids, but undoubtedly the extractives are powerful stimulants and restoratives, and as such they are very useful in some diseases and for forming a basis for soups.

Now it is possible to make similar extracts from marine animals. Take for example the whale, certain species of which are sought after, and captured for their mercantile value in oil or whalebone.

The Normal Company, under the superintendence of Mr Sahlstrom, has recently established a factory in Aberdeen, and has manufactured large quantities of a similar extract from whale flesh. This extract presents all the characters of an extract made from the flesh of the ox. Such an extract forms an excellent basis for a soup, having all the flavour of an extract of ox flesh. But *extracts of fish* can be made in a similar way, the product being, as far as sensible characters are concerned, indistinguishable from that of ox flesh. These are points of difference depending on the slightly different chemical composition of fish and flesh—for, even in the same animal, there is a difference in the chemical composition of individual muscles. Such fish extracts have no flavour of fish whatever, and possess all the aromatic flavour of meat extract, and I understand that they can be made much more cheaply than extract of meat. At a certain point in the process of extraction, all the fishy flavour disappears. As a general rule, these extracts are made by boiling a watery extract of the fish muscles—(after acidulation and precipitation of the proteids or albumins), in an open vessel with a double jacket, so that steam can be admitted between the layers of the jacket, and thus keep up ebullition. Such extracts will keep for a very long time, and they are available for all the purposes for which meat extract is available. The question has still to be tested dietetically, whether such extracts are in any way superior to those of meat. In any case they are quite equal to meat extracts in stimulating and restorative properties.

Such extracts, however, can also be made from other marine animals, *e.g.*, crabs and shell fish generally. In these cases the extract is so made that it retains the flavour of the crab or shell fish, *e.g.*, mussel. Thus there may be manufactured *on the spot* a large amount of extract, which undoubtedly has a commercial and dietetic value. In a properly adjusted dietary, however, mere stimulants and restoratives are not sufficient, but there must be a proper amount and adjustment of the proteids (albumins)—(carbohydrates, such as starches and sugars), fats and mineral salts. The question arises, then—cannot a cheap and useful food be made so as to combine these substances in proper proportion? The whole order of the legume tribe represented by peas, beans, and lentils, have a high dietetic value, and this fact was made use of by the Germans in the manufacture of the famous 'Erbswurst,' or 'iron-ration,' which played so prominent a part in the dietary of the Prussian soldiers during the Franco-German War. Peas, after being boiled and ground, were mixed with a quantity of fat. Peas contain a very large amount of proteid or albuminous matter, and therefore represent a highly nitrogenous food, which, however, when used continuously, is not perfectly adapted to the digestive activities of man. Other forms of solid pea soup and lentil soup are manufactured by French firms, and are supplied in large quantity to the French army, but I cannot say that these soups are very palatable, although I have frequently tasted them, and had them prepared in a variety of ways.

I can speak very highly, however, of the *pea sausage* and *pea soup* manufactured by the Normal Company. The basis of both of these products is peas carefully prepared; they are ground and mixed with a certain proportion of animal fat and extract of fish and flavoured with herbs. Such a solid compressed soup, when boiled for a few minutes in water, yields a most palatable food and one of high dietetic value. The great merit, in addition to its dietetic value, is its cheapness. The dry powder for making such soups can be kept for a very long time without undergoing change. As a matter of fact, in most soups what one obtains is really the extractives and salts and some flavouring materials.

The substances in meat which give rise to the sensations of flavour and sapidity are really most important from a physiological point of view, for they excite powerfully the secretion of the digestive juices, and this greatly aids the process of digestion. Hence, the value of mixing even highly nutritious food with sapid articles. Every one is familiar with the fact that tasteless articles very soon pall on one's palate, and how nauseating they become after a time.

Glue, *gelatin*, and *isinglass* in one or other of their numerous forms are substances which can be made in large amount from the refuse of fish after removal of the flesh. The swim-bladder when boiled yields a specially fine form of isinglass, while coarser forms of glue or cement are obtainable from the bones. A cement of great adhesiveness is made from the skin. Thus a whole series of commercial products of the glue order are obtainable from the refuse of fish, glues suitable for the carpenter, bookbinder, or other trades, while fine isinglass for the nutrition of invalids and for dietetic purposes is also obtained. If the gelatinous product be high coloured, it can easily be decolourised by suitable means. After the extraction of the glue or gelatin from the bones, the latter remain as a beautiful white bleached and quite friable mass, and easily broken residue. This forms excellent *bone-earth* for manure.

As is familiar to most people an *oil* of high medicinal value is obtained from the liver of the cod and other fish. For a long time in the north of Scotland the oil of the liver of the skate has also been used for medicinal purposes. The livers (cod, skate) are carefully selected, washed and cleaned, and the gall-bladder removed. They are then placed in a copper vessel with a double jacket and heated by steam. The oil soon flows out from the liver and collects on the surface where it is skimmed off. An improved method is to allow the oil to percolate to the bottom of the vessel, where it is drawn off at once without being subjected to over-heating or prolonged heating. After filtrating under high pressure much of the stearin is removed. Numerous other marine animals yield similar oils which are not necessarily used for medicinal purposes. Thus a very valuable lubricating oil is obtained from the shark.

The refuse liver after the oil is extracted, may be either burned to get out more oil—train oil—when the residue is used as manure, or it may be compressed to get out the last traces of oil, the compressed residue when mixed with flour forming a suitable food for dogs.

It may seem strange, considering the important part played by vegetables in every duly adjusted dietary, that attention was not directed sooner to the feasability of preparing *extracts of vegetables* as dietetic products, more especially as 'extracts' have long played an important part in pharmacy. It is not to be wondered at, therefore, that Mr Sahlstrom hit upon the idea of combining with the Normal Company's preparations that of vegetable extracts.

The recent researches of Vines and Martin in this country, and other observers abroad, have shown that there is a close analogy between the animal and vegetable proteids, while many of the extractives so-called are common to both kingdoms.

An extract of cabbage, or carrot, or onion retains more or less of the flavour and taste, but if there be a due mixture of vegetables, an extract is obtained which imparts to soup an exceedingly agreeable flavour. Such an extract may be added to any soup prepared solely from animal tissues, so that a pleasant flavour results from the addition of a small quantity of a vegetable extract.

Besides what may be called the classical methods of fish-preservation, such as salting, smoking, and other forms of curing, there are other

methods now available for preserving fish *en masse* in a suitable condition for human food. These methods depend upon the discovery that certain chemical substances retard or arrest the process of putrefaction. The simple method at present in use for preserving fish until they can be conveyed to the great central markets, is merely to place the fish in ice, which by maintaining a low temperature retards the development of those micro-organisms on which the process of putrefaction depends. This may be secured, however, far more satisfactorily with some chemical preparation. The gist of the whole matter comes to be, are such preparations as used for this purpose dangerous to health?

In the newer processes for preserving fish *en masse*, after the removal of the viscera, the first thing to be done is to remove as much air as possible from the fish, by placing them *in vacuo*, and when this is done to subject them, still *in vacuo*, to the action of a solution of common salt, containing a small proportion of boracic acid. It is found that immersion for a short time in such a saline mixture as this, under negative pressure suffices to retard putrefaction; thus the fish can be kept quite fresh for a long time, and remain fit for human food. Boracic acid in the proportion in which it exists in fish 'cured' in this way is not deleterious to health.

The whole question of the value of fish products, therefore, enters on a new phase with (1), the improved methods of preserving fish at the time and in or near the spot where they are caught; and (2), with the manufacture of dietetic and commercial products which themselves command a good price in the market.

It is evident, therefore, that the fish-supplies which are so abundant in the seas around certain remote but perhaps not very accessible parts of our own and adjoining coasts, may be made available for the use of man. Instead of looking merely to the development of a trade carried on by swift steamers, plying between these parts and the markets where fish can be disposed off, it is evident that if factories were planted here and there on our coasts, where fish are known to be plentiful, a vast industry might be created which will bring its reward to those who embark in it, and will also be a benefit to the inhabitants of these districts. By establishing factories for the manufacture of fish extracts,—for which there is a large demand both at home, and especially on the continent,—of glue, gelatine—manure from fish refuse—and by preserving fish *en masse* with the newer and much improved methods, it is evident that there is a new outlet for enterprise, and prospects of a great development of the fishing industry exactly in those localities which for one reason and another are the subject of great commericial depression. The products of these factories are prepared in such a condition that they will keep and can be despatched as occasion requires, so that there will necessarily be less dependence on means of communication and transit than is necessitated by the present imperfect systems for the utilisation of fish and other marine animals.

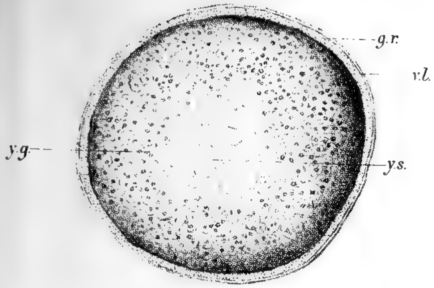
I understand that some such scheme as is outlined above is contemplated by the Normal Company, and already steps have been taken to erect a factory on the West Coast of Scotland.

Many other products of commercial value are obtainable from fish, or from closely related animal products, and the manufacture of the one may be economically combined with that of the other.

All this points therefore to a 'new departure' in the utilisation of the 'harvest of the sea,' and is another instance of the advantage of the application of science and scientific methods to the purposes of commercial enterprise. There cannot be any doubt that such countries as Sweden are far ahead of us in the utilisation of fish products, and it is to be hoped that under the vigorous impulse given to this question by the recent

experiments conducted in this country, and by the interest manifested in this question by the Scottish Fishery Board, a great impulse will be given to the development and extension of our fishing industry. We want more and more to see the application of scientific methods to the development and improvement of our great commercial enterprises. It is astonishing how for centuries the same methods have obtained in the fishing industry, but let us hope that we have entered on a new and prosperous phase of this great national problem. We must look more and more to scientific progress to point the way in which, and to afford the means by which improvements are to be effected. It has been said, and that truly, that 'scientific progress has at all times shown itself to be the surest lever for 'the elevation of our race from its misery.'

PLATE I.



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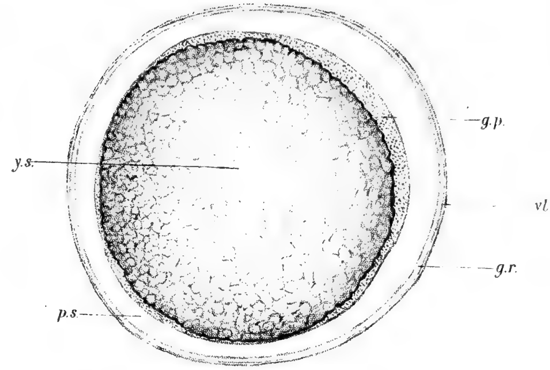

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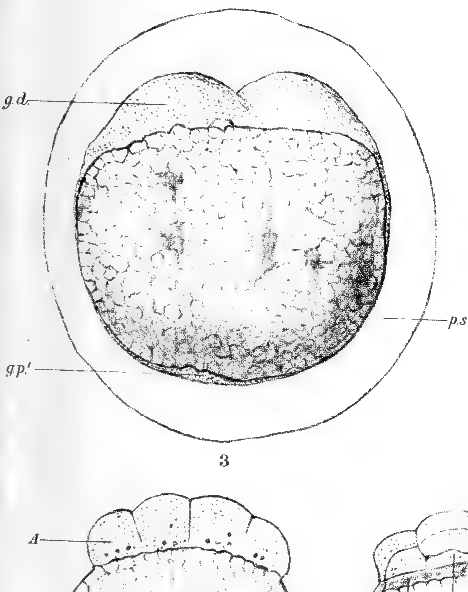

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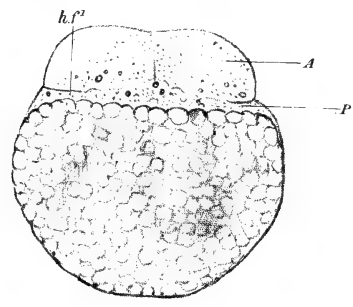

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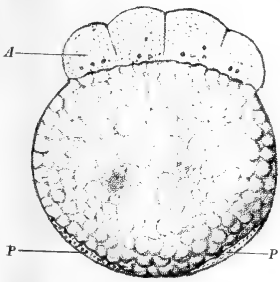

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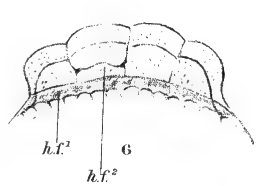

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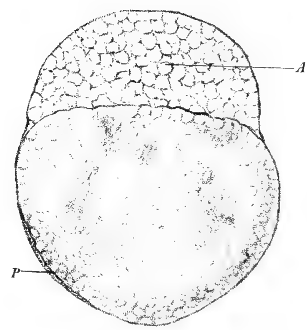

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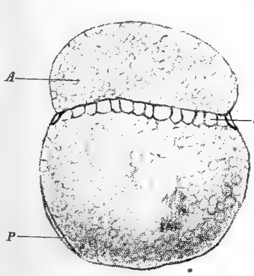

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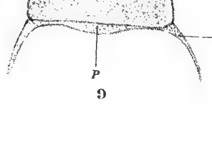

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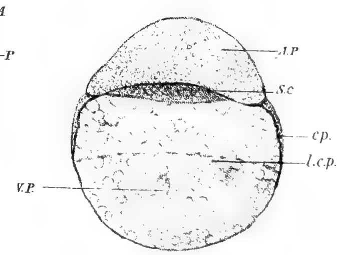

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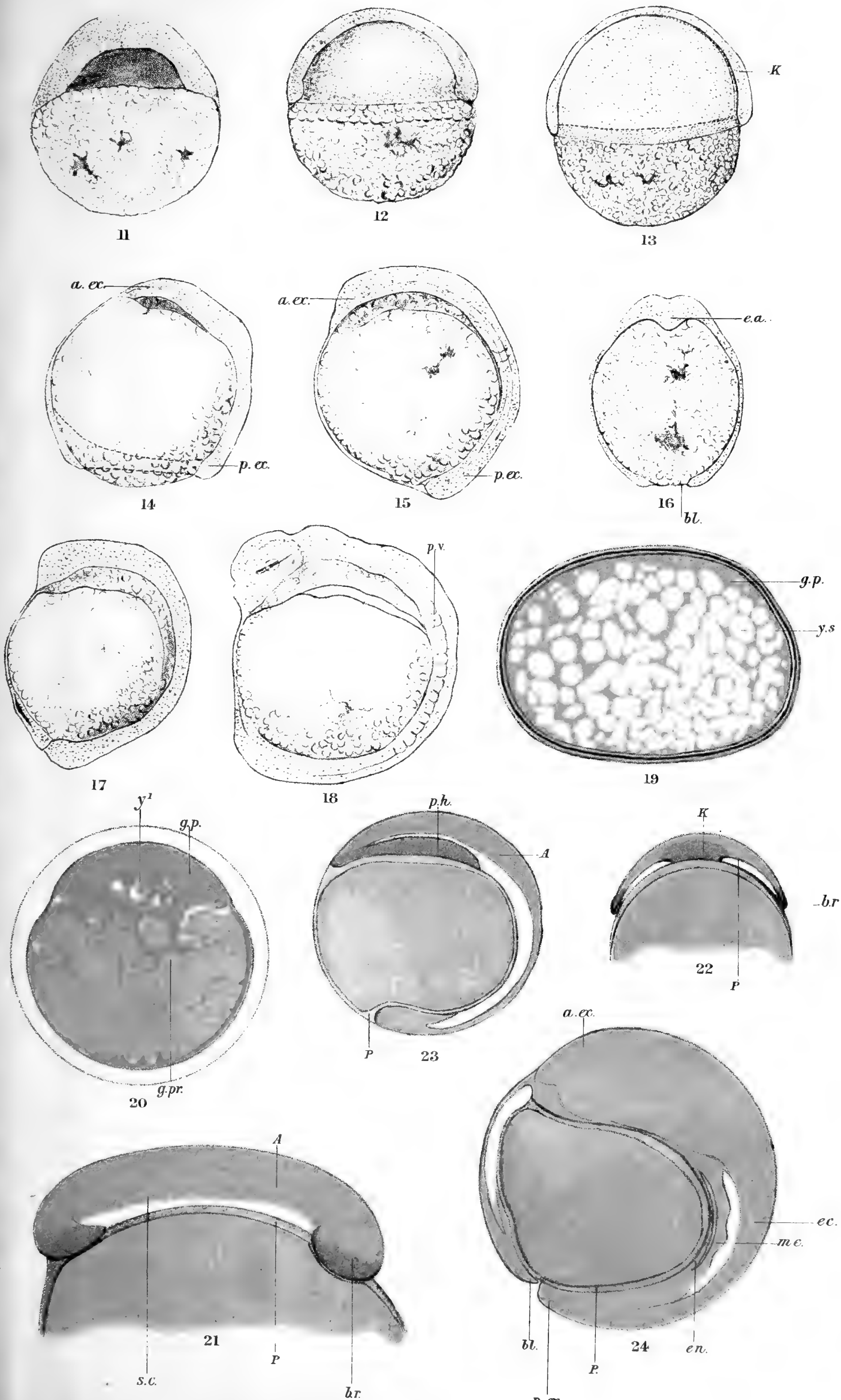

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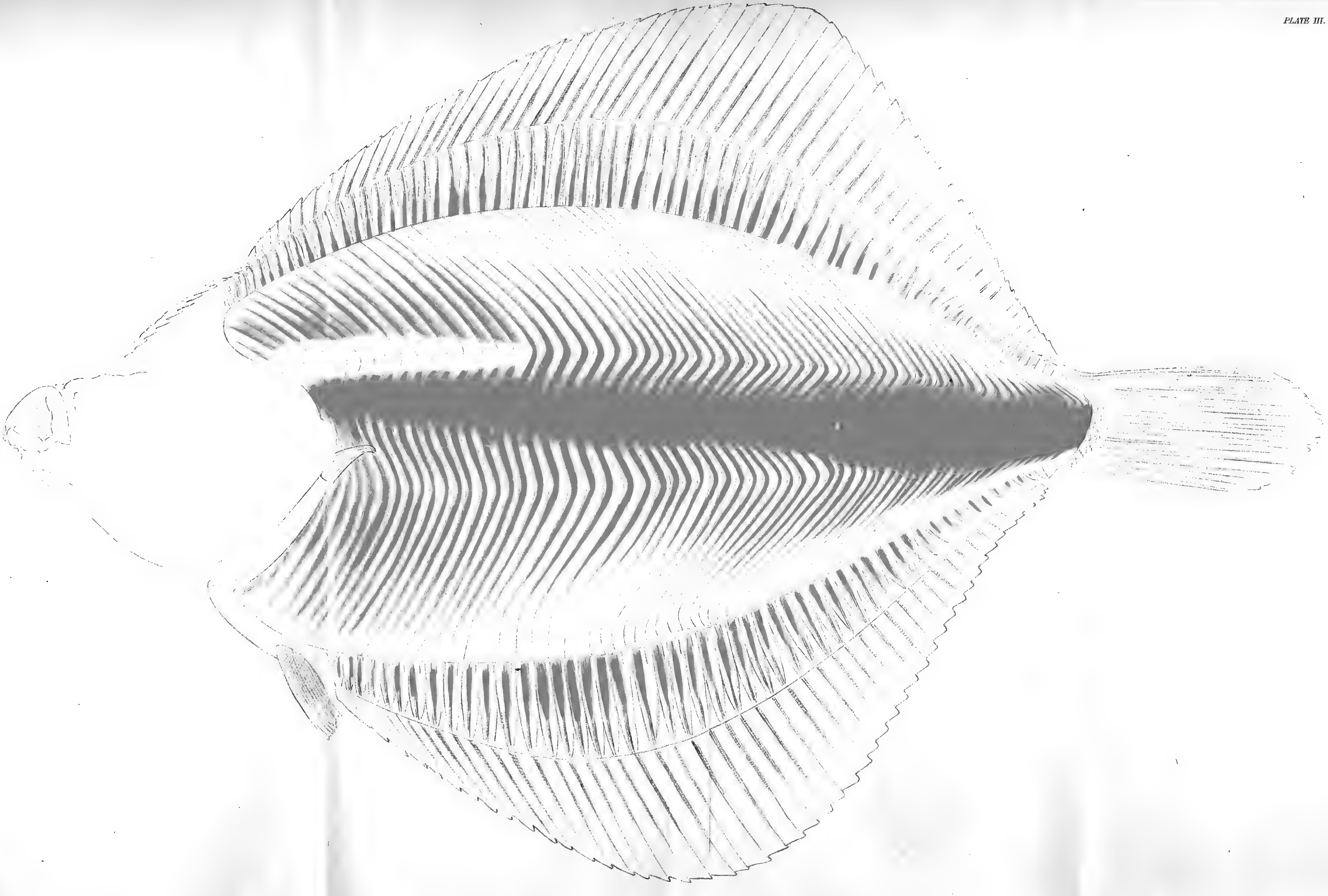

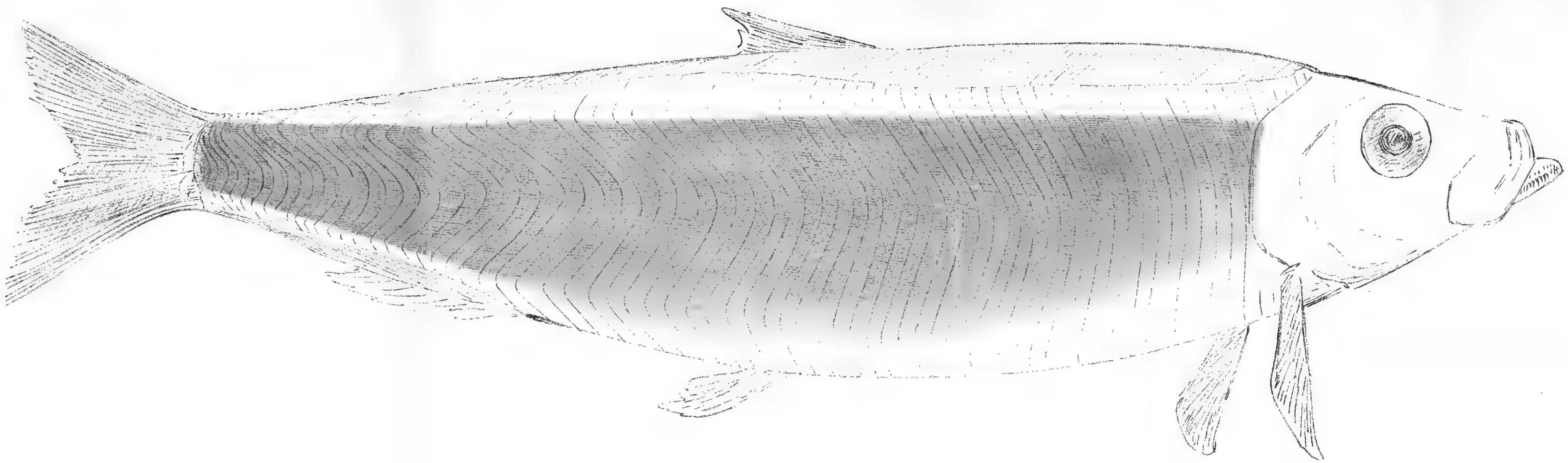

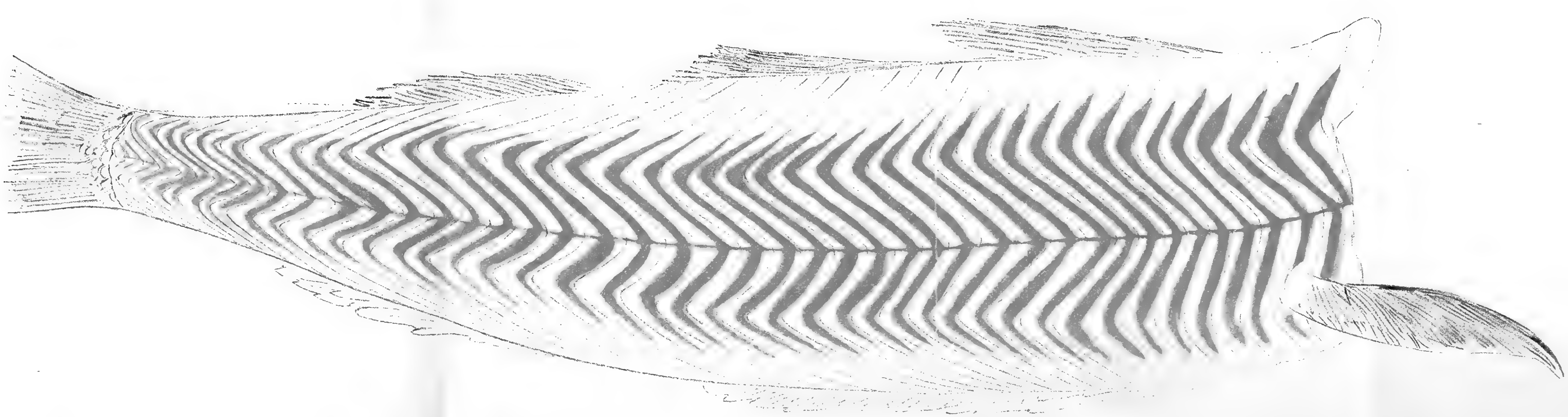

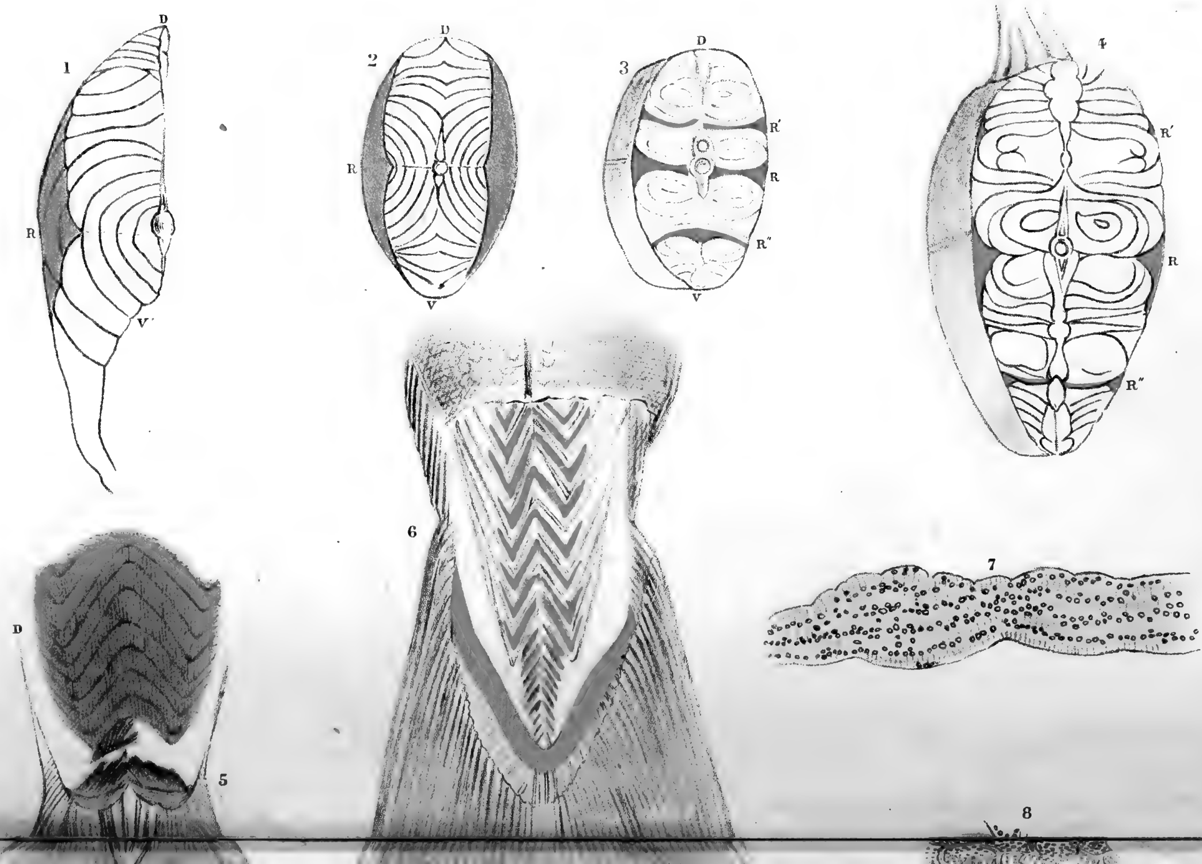

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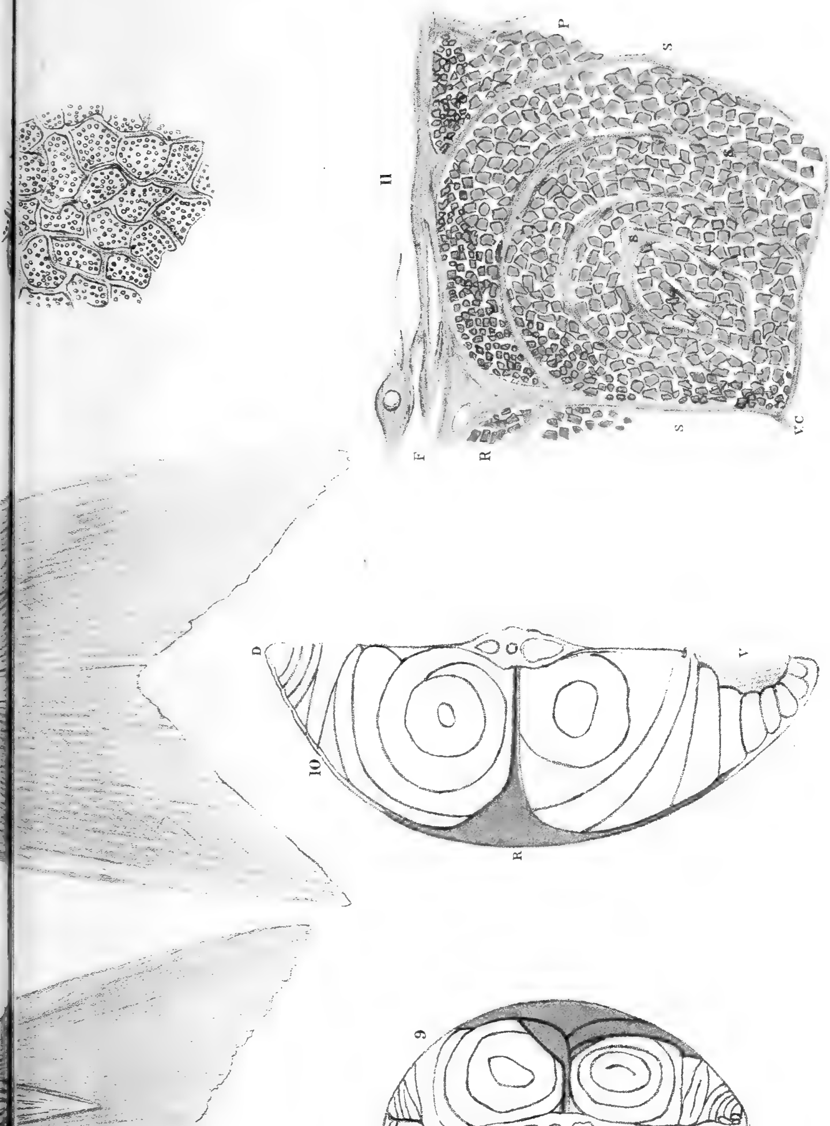
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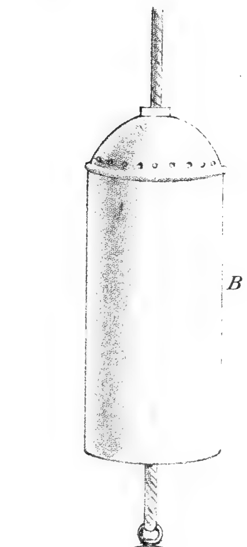
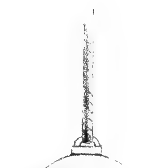


Fig. 1.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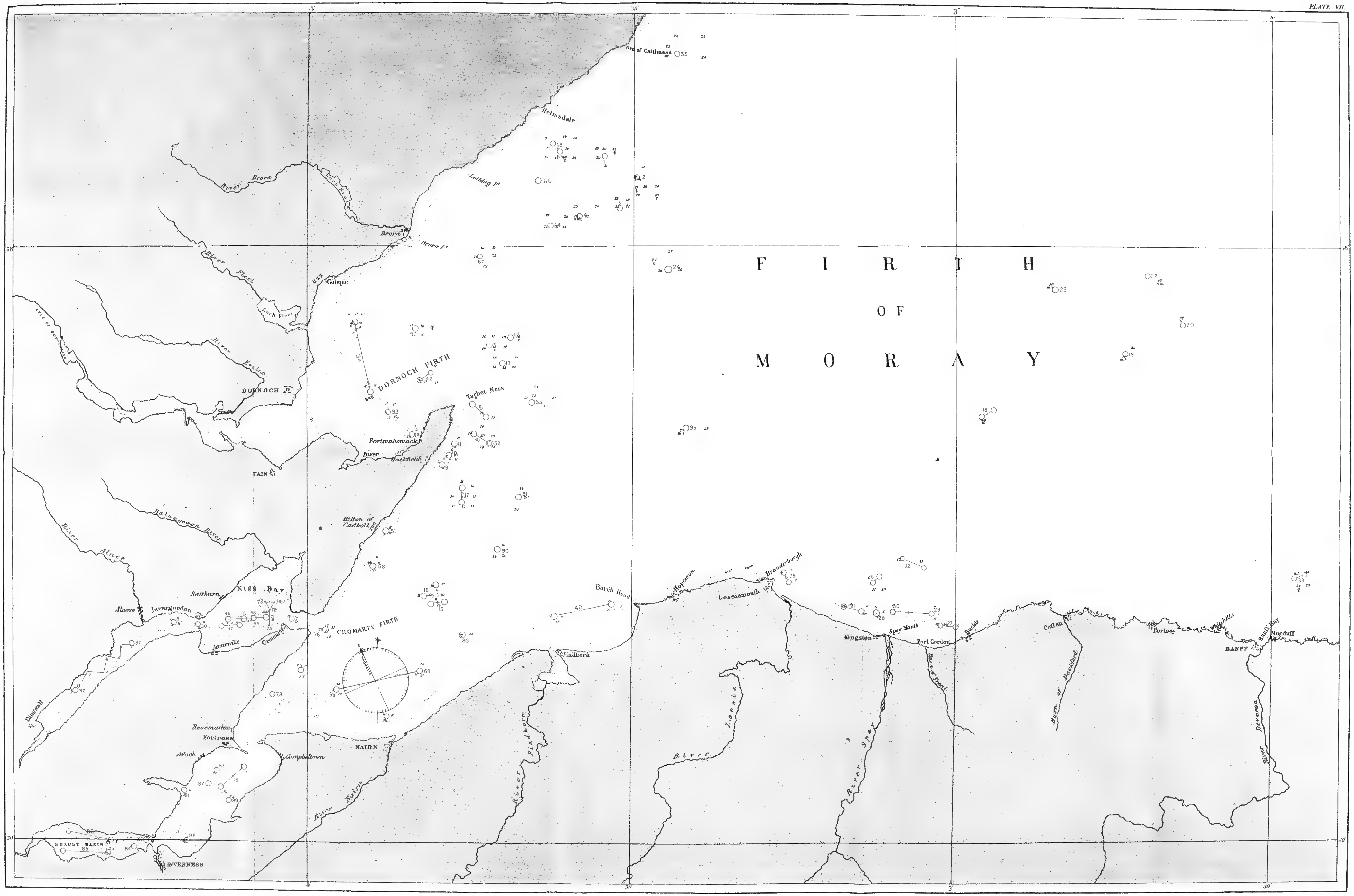
FIRTH OF MORAY
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CROMARTY FIRTH
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Lothbeg Pt
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Loch Brora
Brora
River Fleet
Loch Fleet
Golspie
River Evelix
DORNOCH
Tarbet Ness
Portmahomack
Inver
Rockfield
TAIN
Balnagowan River
River Alness
Hilton of Cadboll
Nigg Bay
Saltburn
Alness
Invergordon
Jemimaville
Cromarty
Dingwall
Rosemarkie
Fortrose
Avoch
Campbeltown
NAIRN
River Nairn
River Findhorn
Findhorn
Burgh Head
Hopeman
Lossiemouth
Branderburgh
River Lossie
Kingston
Spey Mouth
River Spey
Port Gordon
Burn of Tynet
Buckie
Cullen
Burn of Deskford
Portsoy
Whitehills
Banff Bay
BANFF
Macduff
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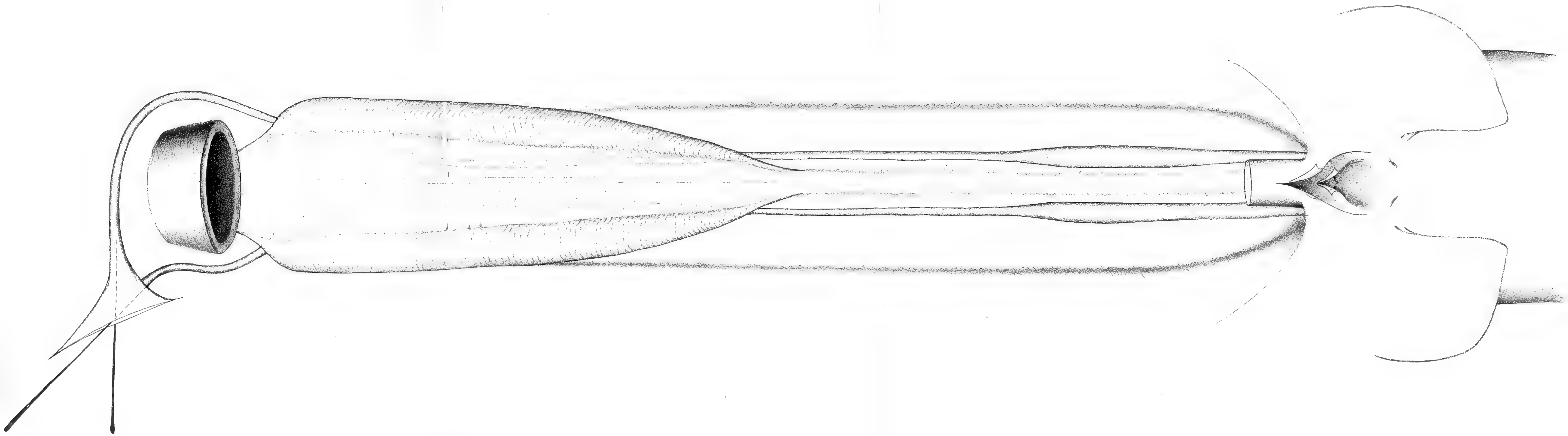
BEAULY BASIN
INVERNESS

THE TUNNY

A.—Ventral Finlet.

ZEUCOPTERUS UNIMACULATUS

PLATE. X



APPENDIX G.—No. I.

FOURTH ANNUAL REPORT TO THE FISHERY BOARD FOR SCOTLAND.

CONTAINING AN ACCOUNT OF

THE SALMON FISHERIES IN THE INNER AND OUTER HEBRIDES.

AND

APPENDIX G.—No. II.

CONTAINING

BYE-LAWS HITHERTO PUBLISHED ONLY IN THE *EDINBURGH GAZETTE*,

AND

THE ANNUAL CLOSE TIMES OF ALL THE SALMON RIVERS IN SCOTLAND, BROUGHT DOWN TO DATE OF REPORT.

By ARCHIBALD YOUNG, Advocate,
Inspector of Salmon Fisheries for Scotland.

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APPENDIX G.

REPORT.

I HAVE the honour to Report that, during the summer of 1885, I made, under the direction of the Fishery Board for Scotland, a careful inspection of the valuable Salmon Fisheries in the Inner and Outer Hebrides. This great group of islands has an area of 2812 square miles, or 1,800,000 acres, with a population, in 1881, of 82,119. Two-thirds of their surface consists of moor or moss, and the whole extent of arable land does not exceed 200,000 acres. The Inner Hebrides are in general composed of trap, while the Long Island, which forms with its adjacent isles and islets the Outer Hebrides, is almost entirely formed of gneiss. A peculiarity of these islands, especially of those belonging to the Outer Hebrides, is the enormous number of lochs. The total number is stated to be 1500, covering 50,000 acres, and a careful observer who counted those in North Uist is stated to have reckoned up, in that island alone, no fewer than 170, without computing mere mountain tarns. Some of these have the most extraordinary and eccentric sinuosities of outline, ramifying in every direction. For example, Loch Maddy, a sea-loch in North Uist, has an area of only 10 square miles and yet it has a coast line of upwards of 200. And among the fresh-water lochs, Loch Scadoway in North Uist, which is said to have an island for every day in the year, Loch Roag and Loch Druidibeg in South Uist, and Loch Trealaval in the Lews, display outlines almost equally irregular and fantastic. These lochs are in general shallow, seldom exceeding 3 or 4 fathoms in depth. The entire number of islands and islets belonging to the Hebridean group has been calculated at 500, of which not more than 100 are inhabited. The Long Island, from the Butt of Lews to Barra Head, is nearly 130 miles in length, and its population is upwards of 25,000. In its rivers and lochs and around its shores are to be found the best fishings in the Hebrides, not only for salmon, but also for herrings, cod and ling, and lobsters.

The great extent of land constituting the Long Island is held by only 5 proprietors. Lady Matheson has 417,416 acres; Sir Samuel E. Scott, Bart., and Lord Dunmore have together 122,500; Sir John Campbell Orde, Bart., has 68,000; and Lady Gordon Cathcart, 120,944 acres; giving an average of 147,372 acres to each proprietor.

The Inner Hebrides, in which there are salmon rivers and lochs, include Skye, Mull, Jura, and the fertile island of Islay. 'If,' says Dr Samuel Johnson, in his *Journey to the Western Islands*, 'it were 'always practicable to fish, these islands would never be in much danger 'of famine; but, unhappily, in the winter, when other provision fails, 'the seas are commonly too rough for nets or boats.'

SKYE.

The island of Skye is the most northern of the Inner Hebrides, and is, next to the Lews, the largest of the whole western group; being 48 miles in extreme length, with an average breadth of 12 miles, though, at one point—from the head of Loch Eishort to the head of Loch-na-Dal—it is only a mile and a half in width; and so deeply are its shores penetrated by bays and sea-lochs that there is no place more than $4\frac{1}{2}$ miles distant from the sea. It has an area of 457 square miles, and a population of 16,889. The name (Skye) has been by some derived from 'Skianach,' that is winged, because of the two opposite promontories—Vaternish lying north-west, and Trotternish north-east—which resemble wings; and Dean Monro, writing, in the end of the 16th century, says:—'This ile is called by the Erishe Ellan Skyane, that is to say, in 'Englishe, the Wingitt ile, be reason it has many wyngs and points 'lyand furth frae it, through the devyding of thir loches.'

At Portree, the capital of Skye, I had the advantage of meeting Mr Lawson, manager to the Messrs Johnston of Montrose, who are the lessees of the net fishings round the coasts of Skye. Mr Lawson has had forty years' acquaintance with these fishings, and is consequently well qualified to give reliable information regarding them. He admitted that the law regarding estuary lines is somewhat loosely observed, as no one objects to its occasional infringement. And here it should be pointed out that, though there are two Fishery Districts in Skye, there is no District Board; so that, in the absence of any official body to enforce the provisions of the Salmon Fishery Acts, it is by no means surprising that, those who have an interest to infringe or evade them should be tempted to do so. There should be only one Fishery District for the whole of Skye, and the District Board should meet at Portree. The best salmon fishing in Skye is along that part of the coast which stretches from Portree to Rudha Hunish, the farthest north point of the island. The earliest good fishing commences in the extreme north, both for salmon and grilse. Along the east coast, the fish are beautiful in shape and excellent in quality; while those in Loch Snizort and along the west coast are inferior to them in both respects. Mr Lawson states that the Skye rivers are decidedly late. He does not put on his full complement of men until the middle or end of May, and he is of opinion that the present close-time, from 27th August to 10th February, should be altered, so as to be from 10th September till 24th February. The heaviest salmon of the season would be captured in this additional fortnight. If this alteration were made, he sees no objection to giving an extension of time for rod-fishing up to 15th November. Skye rivers he says are too small. Fish do not enter them except for spawning purposes. He thinks that many of the fish caught in the bag-nets do not belong to the Skye rivers. He mentioned that a very fine fish of the salmon kind, from 8 to 10 lbs. weight, and occasionally heavier, makes its appearance in the month of July. He is unable, with all his experience, to say whether this fish is a grilse or a salmon. He has tried net-fishing in Loch Snizort into which the largest river in Skye falls, and where one would naturally expect to find a productive fishing-ground; but he soon withdrew the nets as they did not pay. The bag-net fishing round the island of Skye seems to be of considerable value, as Mr Lawson informed me that he has sent off in two

days 100 boxes of salmon. The best fishing season he remembers was that of 1883. There has never been any salmon-disease in Skye. All the salmon caught around the island are sent off direct to London. Skye has a very extensive coast line—upwards of 200 miles—owing to the number of sea-lochs and bays that indent the island. I afterwards saw Mr Macdonald, banker, Portree, who is agent for the three chief proprietors in Skye, and found that his views with regard to the salmon fishings very much coincided with those expressed by Mr Lawson. Like him he admitted the occasional disregard of estuary lines and the weekly close time. But pointed out the difficulty and expense of enforcing the Bye-laws throughout a coast-line so extensive as that of the Island of Skye. The rent paid for the bag-net fishings to the three principal proprietors in Skye is £670.

There are 7 salmon rivers in Skye for which Districts and Estuaries have been fixed under the Acts of 1862 and 1868. Their names are the Sligachan, Broadford, Portree, Snizort, Orley, Oze, and Drynoch. The Snizort is the largest, but they are all comparatively small streams. They are late-seasoned rivers. But at present they are classed under the largest and earliest group of Scotch Salmon Rivers; their annual close-time being from 27th August to 10th February, with extension of time for rod-fishing to 31st October. They ought to belong to the latest group, whose annual close-time extends from 10th September to 24th February.

Broadford River.

I made a careful inspection of these rivers, the Broadford being the first I visited. It rises in a small, reedy, shallow loch called Loch Gilchrist, and, after a winding course of between 4 and 5 miles, falls into the sea near the village of Broadford. At present, bag-nets can be, and are so placed, as to intercept almost every fish seeking the river, the estuary limit being 'a straight line from Mr Mackinnon's Pier on the 'north to the cottage on the beach, a little to the eastward of the Lime 'Kiln and Pier on the south;' and even within these narrow limits bag-nets are occasionally used. There is but a slight fall between Loch Gilchrist and the sea. There are several stretches of good spawning ground in the river bed, and no obstacles of any kind to the free ascent of salmon. As already mentioned, the Broadford is a late river. Evidence to this effect was given 50 years ago before the Select Committee on the Salmon Fisheries of Scotland, by that experienced fisherman and observer the late Mr Robert Buist, who at that time had a lease of salmon fishings in Skye. He then said:—'We get no fish till 'the end of May. It will not pay a man's wages till the month of May. 'They remain in good condition until the 14th September.'

Portree River.

The Portree River, like the Broadford, is but a small stream. In its upper part, the bed is rocky and unsuitable for spawning. But farther down there are several nice pools; and between the stone bridge and the head of the Bay of Portree, into which the river falls, there is some good spawning ground. There are no obstacles to the ascent of salmon. There are no lochs connected with the Portree river, which is very much against it as a fishing stream as it falls and rises with great rapidity, having no reservoir to keep it in good fishing ply after a flood.

Snizort River.

The Snizort River, which flows into the head of Loch Snizort Beg, is the largest stream in Skye—larger than the Broadford and Portree Rivers united. Just above the bridge on the high road which crosses it near the picturesque residence of Mr Macdonald of Skeabost, there is a waterfall which is a serious obstruction to the free ascent of salmon from the sea. I inspected it on two occasions—the first when there was but little water in the river, and the second when it was subsiding after a flood—and I am convinced that it must stop a good many fish. But either by blasting the rock on the left bank, or by putting in a Macdonald Fishway, the obstruction might easily be rendered passable in ordinary states of the river. Above it, there is quite a mile of fine gravelly spawning ground where the river is broad and deep. But below the bridge the river bed is rocky and unsuitable for spawning. Besides the Snizort, there are two other streams—each about the size of the Portree river—which run into Loch Snizort Beg. The one is called the Haultin, and rises at the back of the Storr Mountain, and the other, which joins the loch nearer its mouth, is called the Romsdal. There is a fine pool at the mouth of the Romsdal, 8 or 10 feet deep, even in the low state of the stream when I visited it, into which the tide flows. It looks a splendid place for sea-trout or grilse.

Drynoch River.

A pretty little river called the Drynoch, with a course of 6 or 7 miles, runs into the head of Loch Harport on the west coast of Skye. It is one of the best spawning streams in the island; its bed being chiefly composed of gravel and small stones. Like most of the Skye rivers, it dwindles down to a mere silver thread after a long period of prolonged drought, and I think it not unlikely that some of the spawn deposited may occasionally be lost from the falling of the water leaving the ova dry. There are several good pools in the Drynoch, both above and below the shooting lodge.

Rivers Sligachan, Orley, and Oze.

The Sligachan rises in Hart-a-Corry, one of the wildest corries of the Coolin Mountains; traverses the grand glen of the same name for some miles, hemmed in by the Forest Mountains on the east and the serrated peaks and scarred sides of the Coolins on the west; and finally flows into the head of Loch Sligachan. There are some capital pools in the river about a mile up the glen, and also below Sligachan Inn which are frequented by heavy sea-trout in July and August after a flood. The Orley and Oze are streams about the size of the Sligachan, and flow into Loch Bracadale. None of these rivers can be properly termed good angling streams for salmon. Their smallness alone will not account for this, as rivers in the Lews and Harris, no larger than the Snizort, or Drynoch, or Sligachan, yield splendid sport to the angler. Perhaps, the fact that there are no bag-nets on the coast of Harris, and scarcely any on that of the Lews, whereas, the coast of Skye bristles with them, may account for the poverty of the sport yielded by the Skye rivers, when contrasted with the productiveness of those in the other islands. In old times too, the streams of Skye seem to have been more fruitful in fish; for, in the *Description of the Western Isles of Scotland*, by Dean Monro, who travelled through most of them in the year 1594, there is the following account of the rivers of Skye:—

Within this ile ther is gud take of salmont upon 5 watters principally, to wit, the watter of Sneisport, Sligachan, Straitswardill, Ranlagallan, and Kilmtyne, with seven or aught uther smallar watters, quherupon salmont are also slayne. In this ile, there is a freshe water loche, callit the loche of Glenmoire, quheron ther is abundance of salmont and kipper slayne.

In Martin's *Description of the Western Islands of Scotland*, also, (second edition, published in 1716), there is the following statement :—

There are many rivers in all quarters of the isle, about 30 of them afford salmon.

I select from the answers to the printed queries circulated in Skye, before I commenced my personal inspection, those sent in by two gentlemen long resident in the island, and intimately acquainted with the fisheries. These will shew how very different are the views which may be entertained by individuals of intelligence and ability, both of whom have had ample opportunities of observation. The first of these gentlemen thinks that there should be no weekly slap in Skye, as the fishing is all by bag-nets. He states that the fishing tenants fish in the Minch, a very dangerous sea and coast, and it would be better to take some time off the beginning of the fishing season than to have a weekly slap. The catch of fish has increased because more of the island has been fished by bag-nets. There is no fishing by net and coble, and there are no stake-nets. Not above 20 salmon and grilse are caught annually by the rod on the Skye rivers, and most of these are caught on the Snizort. The principal fishing is of grilse, which lasts about six weeks from the time they appear until the time they go off. If they commence in June they go off quicker; if, in the beginning of July, they continue later; and, in some exceptionally late seasons, they last through August. In the Minch, there is a run of September fish, more or less, every year. There is no need of a District Board in the Island of Skye; proprietors, factors, and their servants being quite sufficient. He considers that the proprietors having material interest should have power to prosecute if necessary with the same powers as the District Boards. He thinks there should be no restriction in Skye as to the mode of fishing, the season is generally so short in which the weight of fish is on the coast. Without fixed nets, hardly any fish would be killed in Skye. No appearance of salmon-disease has been seen in Skye.

The answers sent in by the other gentleman present a very different view of the fisheries, especially as regards the question of fixed nets from that summarised above. The following is an epitome of his opinions :—

I think, now that salmon are taken at so many points along the coast, and that fixed engines are permitted so close to the mouths of rivers, and that in consequence so few fish have a chance of entering, a longer weekly close-time is necessary. I have good reason to know that the Bye-laws regulating the observance of the weekly close-time are not strictly observed in my district. It appears to me that when a department of the Government has been appointed to take these fisheries under their charge, they should not be left as they now are at the mercy of parties whose interest it is to violate the laws made to restrain them. I would suggest for the purpose of enforcing the Weekly Close-time and the Salmon Fishery Laws, the appointment of intelligent fishermen here and there, under the superintendence of the existing Fishery Officers, who are men of intelligence, and would see to the enforcing of the law, if the authority and means were given them. I have no certain information as to whether the take of fish has increased or diminished within a recent period. But I know that the salmon fishings in this parish have, on various occasions, been fished out so completely, that they were for years entirely abandoned. I know that there is nothing like the same quantity of fish in fresh waters that there used to be; and in various places where salmon used to be, there are none now to be seen at any time. I have no means of knowing the number of salmon taken in fixed engines. But I know that fish are so

effectually prevented from entering our streams, that the taking of a salmon or of a large trout is an event so rare as to be a seven days wonder. I think the Secretary of State should have power to alter Estuary Lines on good cause shewn, and to combine or divide Fishery Districts as in the English Salmon Fishery Act of 1873. There cannot be a doubt that, as now permitted, stake-nets and bag-nets are highly injurious to the salmon fishings, though, under some restrictions, they are required for the supply of the market. There cannot be a doubt that the establishment of a Hatchery here would be most advantageous from the various contingencies to which the salmonidæ are exposed. (1) From the smallness of most of our streams, especially at the source where the spawning beds lie, the young fish are more exposed to their natural enemies than in larger streams. (2) Our streams as a rule rise in high ground, consequently have a rapid fall, and run with a degree of violence that must prove fatal to much of the spawn. (3) When in flood, they spread so far beyond their usual bed that numbers of fish deposit their spawn where it is left high and dry until the next flood, which often, if not always, does not reach it until it has lost its vitality. (4) Then almost all the streams have small affluents which run only in time of flood, and when fish enter they and the spawn alike are left to perish. The 'Wild Birds' Protection Act' should, in the interests of salmon fishing, be so far amended as to do away with the protection to the black-backed gull, which is a most destructive enemy to the young salmon. I have constant occasion to pass a lake into which several spawning feeders run, and in which, for some time prior to migration, the smolts seem to rest. For half-a-century I have noticed that, in the early part of May, when the migration of the smolts is about to begin, a large number of black-backed gulls lie at the part of the lake where the smolts leave for the sea, living entirely on smolts and the flock is regularly to be seen at the mouth of the river catching the smolts as they leave for the sea. At this place, the smolts have to wait for a flood to enable them to migrate, and when, as often happens, they are detained for two or three weeks waiting for a spate, a very small proportion of the original number can be left to migrate. It is quite clear that the smolts lie near the mouth of the river, or rather where it leaves the lake, as the gulls, during the whole time, lie at that point of the lake. What I see here, I see in other localities where there are salmonidæ.

I entirely agree with what is stated above regarding the evil done to the salmon fishings in Scotland by that piece of sentimental legislation termed the 'Wild Birds' Protection Act.' But so far as the black-backed gull is concerned, he is expressly excepted from the shelter afforded by the provisions of that Act. Other fish-eating birds are, however, protected, especially the gannet or solan-goose; and, as has been proved where those birds have been kept in captivity, each gannet will eat at least 7 herrings in a day, and no doubt, if smolts came in their way, the gannets would be equally destructive to them. The late Captain Macdonald of the 'Vigilant' fishery cruiser, who was probably better acquainted with Scotch fisheries than any man of his time, gave very strong evidence at Wick in 1877 before Mr Buckland, Mr Walpole, and myself, when we were engaged on a Government Inquiry into the Herring Fisheries of Scotland. He then said:—

The gannet will eat 12 herrings a day, and the gannets eat more herrings than all the fishermen in Scotland take. The gannets breed in the Bass Rock, Ailsa Craig, Stack Rock (off Cape Wrath), St Kilda, and Suliskere, 40 miles north-east of the Butt of Lews. The auk, the guillemot, the puffin,—all under the ægis of the 'Wild Birds' Protection Act,'—and gulls of every species, consume each 20 to 30 young herrings in the day.

Mr Hugh Maclachlan, one of the chief fish-curers and fish-merchants in Glasgow, said that he—

Would repeal the 'Sea Birds' Preservation Act,' as there are thousands of solan-geese about Ailsa Craig which consume as many herrings as the boats annually catch.

Robert M'Connell, fish-buyer, representing the fishermen in Girvan—

Believes that the birds at Ailsa Craig do more harm than a close season would do good. The gannets are protected in a way which is injurious to herring. The gannets have increased very much since the passing of the Sea Birds' Act. There are more than 10,000 gannets in Ailsa Craig, and they will eat 30 herrings each a day.

After a careful consideration of the above, and other evidence of a similar nature, the Commissioners in their Report of 1878 on the Herring Fisheries of Scotland, wrote as follows :—

The destruction of herrings by gannets is enormous. It is estimated that on Ailsa Craig alone there are 10,000 gannets. Assuming that each bird only takes 6 herrings a day, the gannets on Ailsa Craig alone must consume 60,000 herrings a day, 1,800,800 herrings a month, or 21,600,000 herrings a year. On the assumption that there are 50 gannets in the rest of Scotland for every one on Ailsa Craig, the Scotch gannets must consume more than 1,110,000,000 herrings a year, or 37 per cent. more herrings than all the Scotch fishermen catch in their nets.

The Commissioners accordingly recommend that—

The 'Sea Birds' Preservation Act,' protecting gannets and other predaceous birds, which cause a vast annual destruction of herrings, should be repealed in so far as it applies to Scotland.

The answer to this recommendation has been the 'Wild Birds Protec-'tion Act,' which shelters a variety of predaceous and fish-eating birds, which prey upon herrings the food of the poor, and upon salmon fry and smolts, so that at present these birds are encouraged and protected at the expense of the great fishing industries of the country. So recently as January 1886, Mr Anderson of Edinburgh, who has had 50 years' experience as a lessee of salmon fishings, chiefly on the Forth, writes me as follows about the 'Wild Birds Protection Act':—

As to birds, there are a large number that feed on the ova all autumn, and continue all winter, both in the rivers and burns. Then again, whenever the fry starts, they keep on the fords for months. The common duck is most deadly and seemingly privileged by the water-bailiffs. It never stops. In one duck I found 37 young salmon fry, and in another 25. So both had a good breakfast. In a water-hen I found 40 ova, and in another 10 fry ; and in a gull 27 ova, and in another 11 young fry. Fry have been found in a great list of other birds, such as lapwing, turnstone, crane, heron, egret, and every kind of duck and gull.*

Localities in Skye suitable for Mussel and Oyster Culture.

While engaged in inspecting the salmon rivers in Skye and the sea-lochs into which they flow, my own observations convinced me, and my attention was directed to the fact by persons well acquainted with the localities, that these sea-lochs, especially at their heads, afford excellent opportunities for mussel and oyster culture; while farther inquiry shewed me

* The late Mr Robert Buist, for many years superintendent of the Stormontfield Ponds and of the Tay Salmon Fisheries, in a pamphlet published in 1866, entitled *The Stormontfield Piscicultural Experiments,* gives the following graphic account of the damage done to the salmon fry at Stormontfield by fish-eating birds :—'As a 'specimen of the voracity of these gulls, I may mention that the keeper, having shot 'one of them, took out of its maw upwards of 50 of our young fish. This year (1866) 'a long-legged heron was seen stalking about among the fry and gobbling them up. 'The keeper got out his gun and brought him down on the rising. On dying he 'vomited upwards of 50 of our fry. What must the young fish in the river suffer by 'such depredators flying about in hundreds, and picking them up to feed their own 'young ones at that season?'

that, in many of them, oyster and mussel scalps had formerly existed, but have either been dredged out or suffered to decay from want of proper precautions to preserve and improve them. At the head of Portree Loch and of Loch Sligachan, in Loch Snizort Beg, in Loch Harport, in Loch Grishernish, in the Sound of Scalpa, and in various other places, there are suitable localities for mussel and oyster culture. At Romsdal, in Loch Snizort Beg, there is still a mussel scalp, and at the head of Loch Grishernish, where the sea-bottom is better suited than almost any other loch in Skye, there used to be a fine oyster bed. But all the oysters were dredged out in a single night; the story of many a Highland and Orcadian oyster scalp, proving the fact that without police protection there will be no successful and remunerative mussel or oyster cultivation. Yet, in the beginning of last century when oysters were probably not worth a tenth of their present value, and consequently not so attractive to the spoiler, they seem to have existed in Skye in great abundance, as a well known author of that period writes as follows, concerning them :—

All the bays and places of anchorage here abound with most kind of shell-fish. The Kyle of Scalpa affords oysters in such plenty, that commonly a spring-tide of ebb leaves 15 sometimes 20 horse load of them on the sands.

And the writer of the description of the parish of Strath in Skye in the *Statistical Account of Scotland*, published about 60 years ago, states that 'there is a bank of excellent oysters betwixt the coast 'and Scalpa.'

The following letter to me, dated Portree, 10th June, 1885, from Mr Alex. Macdonald, who is factor for Lord Macdonald, Mr M'Leod of Dunvegan, and Major Fraser of Kilmuir, the three chief proprietors in Skye, and who has, therefore, almost unequalled opportunities of ascertaining the state of the island, will shew of how great importance he considers the improvement and development of the mussel and oyster fisheries. He writes as follows :—

With reference to our conversation to-day, and what I mentioned about the much neglected mussel scalps and oyster-beds in Skye, I trust that these will receive the early attention of Parliament, and that powers will be afforded your Board for regulating these very valuable fisheries. To any one who knows the west coast, it is perfectly clear that the sheltered bays and estuaries of Skye would, if due attention were paid to them, form invaluable fisheries, giving much larger revenues, I believe, than the salmon fisheries at present. In many of them there are now oysters, although they are not protected. With care and cultivation there is not the slightest doubt that these fisheries might be greatly extended, and would afford employment to large numbers of our poor population here.

THE SALMON RIVERS OF THE LEWS AND HARRIS.

Coming to the extensive island of the Lews and Harris, by far the largest of the Hebrides, we find the rivers there, though with two exceptions not larger than some of those in Skye, immensely more productive, in fact, for their size by far the most productive rivers in the United Kingdom; which may possibly to some extent, be explained by the fact that there is scarcely any netting, the rental of the whole net fishings around the 250 miles of the sea-coast of the Lews, in 1883, being only £157, whereas, in Skye, almost the whole coast is surrounded by bag-nets and the rental paid to the three chief proprietors for the sea salmon fishings is £670. In fact, there are only 4 netting stations,

worked partly by bag and partly by sweep nets, in the whole of the Lews. These are in Barvas Bay; in Loch Carloway; outside and to the south of Stornoway Bay; and in Loch Resort between the Lews and Harris. In Harris, there is no netting at all, so that salmon, grilse, and sea-trout have at all time free access to the rivers and lochs.

The area of the Lews is 652 square miles, or 417,416 acres; while that of Harris, which is the southern part of the same island, is 191 square miles, or 122,500 acres. The length of the whole island is about 60 miles, the average breadth 5, and the extreme breadth 30 miles. The population is 25,000. It is a land of moor and loch, the fresh water lakes being almost innumerable. Indeed, according to one authority, the name Lews is derived from the Irish 'Leog' which signifies water lying on the surface of the ground.

The salmon rivers in the Lews which have had Fishery Districts allocated to them under the Act of 1862, are the Creed, Laxay, Gress, Laxdale, and Tong, on the east coast, and the Grimersta, Blackwater, and Morsgail, on the west coast. But, besides these, there are many other streams, such as the Arnol, Barvas, and Carloway on the north-west; those in the wide tract of country—over 70,000 acres—known as the Park or Forest between Loch Resort and Loch Seaforth; and those in Uig; which contain sea-trout and salmon.

Some of the best lochs for sea-trout in the Lews, both as regards size and quality, are to be found in the Park such as the Skipnaclet Lochs, the Isginn Lochs, and Loch Lacasdail. In 1874, 150 salmon and 1500 sea-trout were killed in the lochs and streams of the Park; and, in 1882, 9 salmon and 1392 sea-trout.

The Tong.

The first river I inspected in the Lews was the Tong, or Thunga, which flows into a wide, shallow, sandy basin, dry at low-water, termed the Sands of Tong, which lies about 2 miles to the north of Stornoway. It is a famous place for angling for sea-trout, which are both numerous and heavy. The best time is from half-ebb to low-water. The gamekeeper informed me that, though he had seen numbers of sea-trout caught, he had only seen one grilse captured, and never a salmon. There is a considerable fresh-water loch at the head of the Tong, to which salmon as well as sea-trout ascend. Between the Tong and the Gress there are two small rivers called the South Coll and the North Coll, the latter of which has the reputation of being one of the best spawning rivers in the Lews.

The Gress.

The Gress falls into a sort of sea-loch or lagoon, dry at low-water. The lower part winds considerably and has a very slight fall. The consequence is that the pools are long, still, and deep, requiring wind to make the fish rise. Here the sea-trout fishing is often very good, and, occasionally also, that for salmon. The Gress keeper told me that he had seen 25 sea-trout and 5 salmon taken in this part of the river by a single rod in one day. Above the still water, the river assumes a different character, having a rocky bed and a rapid run. There are some capital pools, however, in this part, especially three lying close together which are about half-way between the head of the still water, and what is said to be the deepest and best pool in the river. A little above this pool, the rocky bed of the stream gives place to gravel which continues for some distance up, and here is the chief and best spawning ground.

In a good year, according to the Gress keeper, the total take on the

river might amount to 50 salmon, and 500 sea-trout. Yet the Gress is scarcely so large as the Water-of-Leith at Edinburgh.

I have been furnished, through the kindness of Mr Mackay, Chamberlain of the Lews, with the returns of the Gress fishings for 10 years, and I find that the best year for salmon was 1883, when 78 were captured, and the best for sea-trout was 1871, when 544 were taken. The total number of salmon and sea-trout caught in these 10 years was 303 of the former, and 1612 of the latter. But in one of these years the salmon were not registered, and in another the sea-trout. Taking, however, the returns as they stand, they give a yearly average of 30 salmon and 161 sea-trout, certainly a splendid average for so small a river.

The Laxay.

The day after inspecting the Gress and Tong, I drove to Soval Shooting Lodge, 8 miles south from Stornoway, and, along with the keeper, carefully examined the Laxay from Loch Trealaval to the sea, a distance of about 4 miles. After the Grimersta and the Blackwater, the Laxay is the most productive salmon river in the Lews. In the best year he remembered, the keeper told me, that 145 salmon and 639 sea-trout had been taken in it and in Loch Laxay through which it flows; an average year would yield 100 salmon and 400 sea-trout. About half the salmon are generally captured in Loch Laxay which is a little more than a mile from the sea. Twelve salmon have been taken in a day out of this loch by two rods. There are some fine pools botween Loch Laxay and Loch Trealaval, especially the Ladies pool, which is the best on the river. Near the exit of the Laxay from Loch Trealaval, a sort of dam has been erected in which there is an opening a few feet wide; and when the salmon and sea-trout begin to ascend from the sea this opening is closed by an iron heck or grating, in order to confine the fish to the 4 miles of the river below and to Loch Laxay. The fountain head of the Laxay is not far from the uppermost Grimersta Loch and from the great reservoir of Loch Langavat, whose waters are discharged into Loch Roag through the Grimersta River. There are upwards of 20 lochs belonging to the basin of the Laxay, and when these are once filled with water the river remains in good fishing ply for a long period. Of these lochs, Loch Trealaval is the largest and most remarkable. For, though it is only about 4 miles long, its deeply indented and irregular shores must give it a circumference of probably not less than 20 miles. In these respects Loch Scadoway in North Uist is the only fresh-water loch I know, that can compare with it. It is thus described by an accomplished sportsman, who had 20 years' experience of the rivers and lochs of the Lews :—

> Trealaval is a beautiful fresh water loch, shaped something like a star with numerous bays and outlets, or rather inlets for burns. It was some 3 or 4 miles long, but how many round I never could make out; for it was almost impossible to get round it, unless one knew the particular fords to cross the different streams that ran into it.

I find from returns sent me of the fishings on the Laxay, extending over 9 years, that the best year, 1883, produced 145 salmon and 636 sea-trout, while the poorest, 1880, was 10 salmon and 349 sea-trout. The annual average of the 9 years is 77 salmon and 327 sea-trout.

Loch Orosay.

Within the limits of the shootings attached to Stornoway Castle, there is a considerable loch termed Loch Orosay, or Loch Airidh Sideach on the Ordnance Map. This loch is not above a mile and a half from the

sea, with which it is connected by a large burn; and if salmon and sea-trout were enabled to ascend, it is evident that the angling value of the loch would be immensely increased, as, at present, it contains only yellow trout. I went to inspect this loch, accompanied by the Stornoway Castle keeper, to see whether it could be opened up to the migratory salmonidæ; and if so, whether the improved angling to be thus obtained would be worth the cost of procuring it. We drove a few miles out of Stornoway on the high road leading south, and then walked for some distance across an undulating swampy moor to the loch, which is a fine expanse of water about 5 miles in circumference, with a large island called Eilean Tarnish, near the centre of it. It has a stony bottom and is said to be of considerable depth. A rivulet, much choked up by boulders and with several small falls on it, issues from the loch and flows into a sea-loch termed Loch Grimshadar. After a careful examination of the loch and its surroundings, and following the course of two burns down to the sea, it seemed to me that there are two plans by which salmon and sea-trout might be enabled to ascend; first, by clearing out the course of the stream that runs directly from the lake into Loch Grimshadar; and second by damming up the outlet of Loch Orosay so as to raise its level about 3 feet, and then making a cutting through the moor, about 240 yards long and 6 feet deep, so as to divert the waters of the loch into a stream called the Alt-na-Graoibhe, which is twice as large as the burn which flows from Loch Orosay. This stream, into which the waters would be diverted, by the proposed cutting falls into the sea at Tob Leirabhaidh, a small bay outside and to the south of the Stornoway lighthouse, where there is a station for fishing for salmon with net and coble. There are no serious obstructions in the channel of this stream, though its bed would require cleaning out and deepening in some places. There is, however, a fall near its mouth, a little above where it joins the sea, which has been blasted to some extent but not sufficiently. A subsidiary dam should be made below this fall—the materials for which are lying ready to hand—so as to raise the water on the face of the main fall. The cost of the cutting through the moor above mentioned is calculated by the Stornoway Castle keeper at £30, as labour is cheap in the Lews, and men can be got to work for 2s. per day. The other plan, namely, the cleaning out the channel of the burn, which is the natural outlet of the loch, would cost more but would, in my opinion, probably be more effectual. I don't think it could be carried out under £100. But Mackenzie the keeper, whose experience and intelligence give great weight to his opinion, believes that £60 would cover the cost. The heaviest work would be in a picturesque rocky ravine, at least 60 yards long, about a mile from the sea. Here, there is a waterfall and a great conglomeration of huge boulders heaped around and about the channel of the stream. The fall might be easily managed, but the removal of the boulders would present greater difficulties.

It would be a much less expensive, and possibly also a more successful experiment, to stock this loch with the land-locked salmon or even with the black bass, than to make the connection between it and the sea of such a nature as to allow the migratory salmonidæ to ascend freely. Both these species of fish have already been introduced into this country, and both reach a weight of from 5 to 10 lbs. The brown trout in most of the Lews lochs are but of middling quality, far inferior, for example, to those in the Sutherlandshire lakes. It would, therefore, be a good exchange to have the larger and more sporting fish introduced into Loch Orosay, even at the expense of thinning out or exterminating the brown trout. When Colonel Macdonald, Commissioner of Fisheries in the United States, and inventor of the famous 'Macdonald Fishway,' was in

Scotland in the summer and autumn of 1884, he mentioned the land-locked salmon to me as, in his opinion, one of the American food-fishes best suited for introduction into many of our Scotch lakes. In appearance and quality it is not unlike the migratory salmon. As regards size, the land-locked variety, not unfrequently, attains a weight of 12 lbs., and is occasionally got of even larger dimensions. But, in most of the lakes and streams of the United States, it is much smaller, 5 lbs. being about the average weight. In order to enable the land-locked salmon to grow and thrive, it is not necessary that the sheet of water in which it is placed should be a large one. An area of a few hundred acres is quite sufficient. Thus, the largest fish in Grand Lake region are found in West Musquash Lake which scarcely covers 1000 acres. Depth of water appears to be of greater consequence than extent of surface; and as a rule, the largest salmon are found in deep lakes. Lake Sebago, for instance, one of the most famous haunts of the land-locked salmon, and where they attain very large dimensions, has a depth of 410 feet; and West Musquash Lake is known to be in some places 150 feet deep; while Vermont Lake and Grand Lake, two other favourite resorts, are 115 and 130 feet deep respectively. Most of the lochs in the Long Island, which are seldom above 3 or 4 fathoms in depth, would, therefore, be too shallow for the land-locked salmon. But the lake in the castle grounds which I inspected is said to be, and looks like a deep loch, and it has a fine shingly bottom. It might, therefore, turn out to be quite a suitable locality for this fine fish, and the experiment might be worth trying.

As to the black bass, so great a favourite among American anglers, it is more predatory and voracious than the land-locked salmon, and if it were introduced it would speedily clear out all the other fish and keep the loch for himself. The bass takes either artificial fly, minnow, worm, or spoon-bait, and when hooked is one of the gamest of fish. It has lately been introduced into Germany and into this country, and seems likely to thrive; though it should never be placed in waters where there are salmon and sea-trout or yellow trout of a fine quality. But, where there are only coarse fish, such as pike, or perch, or common trout poor in quality and size, the black bass promises to be a valuable addition to our stock of sporting fishes. It spawns in June and July. It was first brought over to this country by that eminent and enterprising pisciculturist, the Marquis of Exeter, who has now some thousands of Black Bass in Whitewater Lake near Burleigh House, where they have already attained a weight of 3 lbs. But when the food and water are suitable, they are said to reach 10 and even 12 lbs. weight.

The Creed.

In the course of the day, we crossed the little river Creed which flows through the grounds of Stornoway Castle, and which, with the lochs connected with it, is reserved for the use of the family and guests at the castle. There are upwards of a dozen lochs belonging to the basin of the Creed, the best of which is Loch Creed, in which the salmon angling is superior to that in the river. The river is only moderately fished; but the keeper said that, if regularly fished, it would yield in a good year 80 salmon and 150 sea-trout. In a favourable day with Loch Creed and the river in good trim, a skilful fisherman should take 4 salmon in the loch or 3 in the river. Mackenzie informed me that both salmon and trout in the Lews take best near the edges of the lochs; and that, in Loch Creed, you will take as many salmon fishing from the shore, the wind being favourable, as you will from a boat.

The Blackwater.

On the 18th June, during a cold and rainy day, I drove 14 miles from Stornoway to the inn at Garynahine, near which the Blackwater, the second largest and second best salmon river in the Lews, flows into the head of Loch Roag. Nearly a score of lochs belong to its basin. The Blackwater is a late river, and the earliest fish caught in it for 7 years was taken on the 2nd of June last. The best fishing months are July, August, and September. A former lessee of the Blackwater dammed up the outlet of one of the lochs connected with it and constructed sluices so that an artificial flood could be let down at pleasure, to meet the high spring tides which bring the fish up to the rivers' mouth which they enter, wind and water permitting. The attempt was successful, and the gentleman who made it writes thus of the result:—

I found the experiment answer perfectly, and over and over again I ascertained to demonstration that the fish took the river with my artificial, just as they would with a natural spate. By the same process I also sent to sea early the foul fish.

Though this has proved a decided success and has greatly benefited the angling on the Blackwater, yet, strange to say, the same experiment was tried on the Grimersta, the best salmon river in the Lews, which also falls into Loch Roag, and entirely failed in producing the desired effect, though it was continued for several years. A dam and sluices were erected at the outlet of Loch Langavat, by far the largest sheet of water in the Hebrides, which feeds both the river Grimersta and the lochs in its basin on which boats are kept by the lessees of the fishings. The object, of course, was that when the river was low and fish waiting in Loch Roag to ascend, they might be induced to do so by raising the sluices and sending down an artificial flood from the wide expanse of Loch Langavat. The experiment was repeatedly tried but always failed. Some inscrutable instinct seemed to enable the salmon to discern that the water from this spring-fed mountain lake was different from a rain flood. They entered the river indeed, but the water seemed soon to sicken them and drive them from the two lochs immediately below Loch Langavat, from whence the ponded up water issued into the lower lakes, and comparatively few fish were caught in these upper lochs; while, in the two lochs, farthest from the sluices and nearest the sea, the fishing was rather improved. The gillies termed this artificial flood 'rotten water.' The result was, that the sluices were removed and nature was left to do her work unaided. I am unable to say why this experiment of a dam and sluices and an artificial flood should have failed in the case of the Grimersta, and have proved a success in the case of the Blackwater, as both rivers fall into the head of Loch Roag, and their mouths are only a couple of miles distant from each other.

Two streams, one rising in Loch Tairbert, and the other in Loch Leoid, unite to form the Blackwater, and between the junction of these two and the sea, there are several magnificent streams and pools on the main river; what is known as the 'Big Pool' with the stream running into it being the crack cast on the river. Below this, there is a long stretch of deep still water with banks somewhat overhanging. This is generally full of fish, but it needs a strong wind to strike upon it before they will rise freely. Occasionally, however, splendid sport has been obtained, as many as 26 salmon having been taken out of it by a single rod in one day. But the Blackwater and Grimersta were not always as good salmon rivers as they are to-day, when, for a long term of years,

there have been no nets nearer than 20 miles from their mouths. Their state, many years ago, is thus described by the author of *Twenty Years' Reminiscences of the Lews*, than whom no man had a more extensive and accurate knowledge of the fisheries:—

At the time I am speaking of, Hogarth had the net fishing of the island of Lews, and his bag-nets had effectually done their work—so effectually, that he begged to be allowed to give up his lease, as he had fished out the island and would be a heavy loser if held to it. This resignation the proprietor wisely and generously accepted, but as far as salmon were concerned the mischief was done. I do not think that during the month we were at Callernish, we killed above 3 or 4 grilse. The Blackwater, about 2 miles off, attached to the Soval shootings, we never tried as it was very low; and Hogarth's fishermen—and no men knew better—assured us there was little use, for they thought there was not a single fish in the river.

The account given above was corroborated by Angus Mackay, one of the oldest fishermen in the Lews, and particularly well acquainted with the Grimersta, whom I met and examined at the house of the keeper at Stornoway Castle. Mackay said that he came to the Lews in 1835 or 1836. At that time, the Hogarths had netted the Grimersta for a number of years, until at length the netting was no longer worth having. Then they gave it up and the river had a jubilee, in consequence of which the fishings soon recovered. He thinks the reason that the Grimersta is the earliest river in the Lews arises from the distance that the fish have to go up to spawn; for, though there is good spawning ground between the uppermost Grimersta Loch and the foot of Loch Langavat, the principal spawning beds are far above that in the streams that fall into the head of Loch Langavat. On the Blackwater, on the other hand, the chief spawning ground is in the three miles of river between Loch Tairbert and the sea, and the fish have but a short distance to go. At present, the rod-fishing in the Lews continues until the 31st October. Mackay thinks it would be better that it closed on the 15th, as after that the fish are out of condition. But, practically, this is not of much consequence as very few gentlemen fish between the 15th and 31st.

The Grimersta.

The Grimersta, with the lochs belonging to its basin between Loch Langavat and the sea, is, undoubtedly, the most productive salmon river in the Hebrides, and probably for its size, in the United Kingdom. The best fishing is in summer and autumn. But it is the only river in the Lews that has a spring season likewise, when the fish caught, though much scarcer are also much larger than those taken later in the season. One gentleman, with 20 years' experience of fishing in the Lews, states that he has caught 3 or 4 spring fish in a day in the Grimersta; whereas in the Blackwater, he caught but 2 in 20 years, and in the Laxay scarcely a dozen in the same period. 'Why the Grimersta'—he writes, 'has this 'superiority I cannot say, only that it has it.' Both in length and in drainage area, the Grimersta is by far the largest and most important of Hebridean rivers. From the head of the Langadale, the chief feeder of Loch Langavat, to the point where it joins the sea at Loch Roag, is at least 17 miles, of which 8 are occupied by Loch Langavat, which is quite an inland sea, but which, owing to its remoteness and inaccessibility, is scarcely ever visited except by sportsmen and gillies. Between the foot of Langavat and the head of Loch Roag, the Grimersta flows through 4 considerable lakes, in which are the best salmon casts, and on which boats are kept by the lessees. As already mentioned, the chief fishing is

in the summer and autumn months. The salmon are small, averaging about 8 lbs. But they are very numerous and rise freely to the fly. Several years ago I spent some days at the Grimersta Lodge, and the average number of fish brought in per day by the 5 rods who were fishing was from 25 to 30. But I was told that as many as 12 and 15 salmon had, not unfrequently, been brought in by one of the party in a single day, and that, in the brackish water at the junction of the Grimersta with Loch Roag, 100 sea-trout, most of them small, were once captured in a day by the late Dr Key. The author of *Twenty Years' Reminiscences in the Lews*, mentions that he, on one occasion, took 87 sea-trout in the mouth of the Blackwater, which shows in what great shoals these fish come up Loch Roag from the sea to seek the fresh water. The same gentleman gives the following reason for the excellence of the fishing in the Grimersta Lochs :—

I attribute the superiority of the salmon casts in the Grimersta Lochs to those of any of the other lochs in the Lews, to their being supplied with a very large body of water, as they form the outlet of the extensive and fine Loch Langavat, that receives all the waters of that side of Harris that runs into Glen Langan ; and the Grimersta has this advantage that there is spring fishing in it, provided the weather is not too cold and there is no snow on the hills or in the water.

From a return kindly furnished me by Mr Mackay, Chamberlain of the Lews, I find that 1873, the best season on the Grimersta between 1871 and 1884, both inclusive, yielded 1000 salmon and 1073 sea-trout, and that 1883, the next best, yielded 865 salmon and 1339 sea-trout. The yield of the whole 14 years amounted to 7643 salmon and 13,509 sea-trout; or an annual average of 545 salmon and 964 sea-trout, fairly caught by rod and fly.

The Morsgail.

The next river I inspected was the Morsgail, a beautiful salmon stream, that flows into Little Loch Roag, the head of which seemed to me very well suited for mussel or oyster culture. It was in splendid fishing ply when I saw it, owing to the recent rains. It rises in Loch Morsgail, and has a course of a little over a mile before it joins the sea. Both the river and loch abound in salmon, grilse, and sea-trout in the summer and autumn. The lower part of the river might be much improved by pooling in some places. But the upper part has a succession of beautiful natural pools, especially one long wide pool beneath a perpendicular rocky bank, and another below a smaller rock a little further down the stream. Loch Morsgail is a circular lake about 2 miles in circumference. I have the returns of the Morsgail fishings from 1879 to 1884, both inclusive, from which I find that 272 salmon and 4289 sea-trout were killed in the 6 years, or an annual average of 45 salmon and 714 sea-trout. The two best years were 1882 and 1883. In the former, 9 salmon and no fewer than 1375 sea-trout were captured; and in the latter 94 salmon and 926 sea-trout. It is somewhat curious that the former year, while by far the worst for salmon, should have been, at the same time, by far the best for sea-trout.

There is a small fishing and shooting at a place called Scaliscro, about half way down the east side of Little Loch Roag, near which there are said to be some fairly good small streams and lochs which yielded, in 1881, 5 salmon and 80 sea-trout; in 1882, 9 salmon and 13 sea-trout; in 1883, 63 sea-trout; and in 1884, 49 sea-trout.

The Carloway, Barvas and Arnol.

After leaving Garynahine from which I had inspected the Blackwater, Morsgail, and Grimersta, I drove along the side of Loch Roag to Carloway, and from Carloway to Barvas, crossing the River Arnol by the way. Carloway Bay, Mr Mackay, the Chamberlain of the Lews, informed me, was famous 40 years ago for producing the finest oysters in the island. But they have long since been all dredged out. Oysters are still to be found, however, at the head of Loch Roag, not far from the Grimersta Lodge.* A pretty little river with fine streams and pools, and some considerable lochs belonging to its basin, falls into the head of Loch Carloway. But, strange to say, it forms an exception to the rivers in the island, where fish in general rise so freely. Salmon won't take in the Carloway River. Mr Anderson in his *Lewsiana*, published in 1875, says:—

> Numberless lochs in the neighbourhood abound with brown trout, and those whence the Carloway is fed are well supplied with sea-trout and salmon. These latter, however, never rise to the angler in the Carloway River.

And the author of *Twenty Years' Reminiscences of the Lews*, speaks of—

> That deceiving Carloway River, with its nice pools, rushing streams, and long deep, apparently good holding water, in which one never saw or got a fish.

The next salmon river I came to was the Arnol, which has a course of 7 or 8 miles. There are 3 lochs at the head of its principal branch. At its mouth, it forms a fresh water loch quite close to the sea, and there is much good gravelly spawning ground in the mile or so of river between this loch and the bridge on the high road. Between the Arnol and the Barvas, there is another stream with two large lochs connected with its basin, the lowest one a couple of miles long and not much above a mile distant from the sea. Yet, I was told by the Stornoway Castle keeper that salmon and sea-trout never find their way to it. The reason is not far to seek. Just below where the road crosses the stream, there is one of the old mills of the country, and a rough stone dam has been thrown across the water in a diagonal direction, in order to supply water for the mill, which belongs to a neighbouring village, and to which any of the inhabitants may come and grind their corn in a rough way, the husk and the grain being ground together. There was a good deal of water in the stream at the time I examined it; but, notwithstanding, the dam formed a complete barrier to the ascent of salmon or sea-trout. It would, however, be easy so to arrange matters as to supply the mill, and likewise to allow the passage of fish to the lochs above.

A couple of miles beyond this is the Barvas, a nice little salmon river, which I inspected from the inn at Barvas. It has changed its mouth within the last few years, and now expands into a large fresh water loch

* Since the above was printed, Mr Harvie Brown of Dunipace, whose acquaintance with the fisheries on the West Coast is both accurate and extensive, has favoured me with the following note regarding a bed of excellent oysters in a loch on the south-west of the Lews, spelt Loch Thamanabhaidh (pronounced Hamanavay):—'Returned 'from the trout lochs to the yacht, and with my trout landing-net from the boat 'caught up several dozens of delicious oysters, which we opened and eat on the spot. 'This was close to the mouth of the little river; but in slightly deeper water we 'could see hundreds of others and many empty shells. Our yacht lay 150 yards 'from shore in 9 fathoms, but all the edges of the circular loch are about 12 feet deep. 'The rocks go straight down, but the bottom is a thick, muddy or gravelly deposit, 'possibly diatomite in course of formation. The flavour of these oysters was superior 'to any I ever tasted, and that in the month of June. A large bed could easily be 'formed here; but even if naturally fished, and not too much dragging on the shell, 'or gravel banks, or mud, a very fair supply could be reared on the shallow parts 'reserving the deeper parts for fishing.'

shortly before joining the sea. There is a netting station near the mouth of the Barvas. The lower part of the bed of the river is not well suited for spawning purposes. But about a mile above the bridge, close to the inn, its character changes, and there are many beds of beautiful gravel, and some nice-looking pools. The Barvas has a course of about 8 miles, and rises in a loch of the same name. It does not seem to be a productive river, as the best year for which I have the returns, shews a catch of only 30 salmon.

An old writer in the Western Islands, mentions a curious custom in connection with the salmon fishing in the Barvas River :—

The natives, he says, in the village of Barvas, retain an ancient custom of sending a man very early to cross Barvas River, every first day of May, to prevent any females crossing it first ; for that they say would hinder the salmon from coming into the river all the year round : they pretend to have learned this from a foreign sailor who was shipwrecked upon the coast some time ago. This observation they maintain to be true from experience.

This superstition, however, seems to have died out, as I heard nothing of it at Barvas or elsewhere in the Lews.

Uig.

The remote and wild district of Uig contains several streams and lochs frequented by sea-trout and salmon. One of the lochs—Loch Suainabhal —is the largest expanse of fresh water in the Lews, next to Loch Langavat. In one year (1875), these waters yielded 391 salmon and 1003 sea-trout. But, during that year, most of the fish were taken by the net. In 1882, 22 salmon and 429 sea-trout were captured by the rod. Some of the streams and lochs also which are attached to the Aline Shootings, close to the Harris border, contain salmon and sea-trout. Out of 8 years for which I have the returns, I find that the best was 1876, when 11 salmon and 412 sea-trout were taken.

List of Fish caught in the Lews.

The table on the next page, for which I am indebted to Mr Mackay, Chamberlain of the Lews, gives a 'List of salmon, sea-trout, and brown trout 'killed on the different shootings in the Lews, from 1871 to 1884 inclusive.'

From Stornoway to Tarbert.

It is 36 miles from Stornoway to Tarbert in Harris; and in bad weather, such as that which I experienced, a more dreary drive for two-thirds of the way can scarcely be imagined. You pass over a flat or undulating expanse of brown treeless moorland, dotted over with dismal lochs, and traversed here and there by leaden-coloured streams flowing towards the stormy Minch. All is grim, and grey, and monotonous. When you come near the hills of the Park and the mountains of Harris, however, the aspect of the scenery somewhat improves; and as you approach Tarbert by the road which scales the steep shoulders of Cleisham, the highest mountain in the Long Island, it becomes decidedly grand and picturesque.

It was near the end of June when I drove across Cleisham; yet, not far from the highest point of the road, I encountered a violent hail-storm which lasted for nearly half-an-hour.

HARRIS.

The parish of Harris, belonging to the county of Inverness, comprehends the southern part of the Lews and many adjacent islands and islets,

including St Kilda, far away over the 'melancholy main.' Harris is connected with the Lews by a neck of land 7 miles broad between the heads of Loch Seaforth and Loch Resort. It measures 21 miles in extreme length and 18 miles in extreme breadth, and its area is 122,500 acres. It is almost cut asunder in the middle by East and West Loch Tarbert; the strip of ground between the heads of the two being less than a mile across. The coasts of Harris are deeply furrowed and indented by bays and sea-lochs, so that the breadth is very variable, not exceeding an average of

LIST of SALMON, SEA-TROUT, and BROWN TROUT, killed on the different Shootings in THE LEWS, from 1871 to 1884 inclusive.

Name of Shooting.	1871.			1872.			1873.			1874.			1875.			1876.			1877.		
	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout.
1. Soval, . .	*	*	*	40	200	50	109	150	*	*	*	*	*	*	*	*	*	*	*	*	*
2. Gress, . .	27	544	509	52	90	115	16	300	*	*	*	*	43	*	*	*	*	*	—	—	—
3. Park, . .	4	300	*	*	300	*	3	300	*	150	1500	*	57	870	*	14	140	*	1	798	*
4. Aline, .	0	0	0	0	0	0	2	72	*	2	67	*	2	74	*	11	412	*	*	*	*
5. Scaliscro,	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6. Grimersta,	298	1284	*	619	1489	*	1000	1073	*	800	932	*	756	1415	*	722	627	*	732	585	*
7. Barvas, .	4	0	0	18	0	0	0	0	0	0	0	0	4	0	0	—	—	—	—	—	—
8. Uig, .	2	0	*	4	4	*	14	*	*	4	134	*	391	1003	*	—	—	—	—	—	—
9. Morsgail, .	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Name of Shooting.	1878.			1879.			1880.			1881.			1882.			1883.			1884.		
	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout.	Salmon.	Sea-Trout.	Brown Trout
1. Soval, . .	56	240	200	69	185	155	10	349	83	109	337	400	74	403	128	145	636	97	88	444	98
2. Gress, . .	—	—	—	8	21	200	*	25	*	38	257	100	21	170	100	78	94	303	20	111	128
3. Park, . .	18	400	*	17	104	*	45	861	*	76	844	277	9	1392	393	—	—	—	—	—	—
4. Aline, .	1	0	100	*	*	*	*	*	*	0	0	0	1	400	400	6	120	*	0	200	250
5. Scaliscro,	—	—	—	—	—	—	0	0	0	5	80	30	9	13	*	0	68	36	0	49	67
6. Grimersta,	495	804	*	412	796	*	373	965	*	525	899	*	399	859	*	865	1339	*	647	462	*
7. Barvas, .	—	—	—	—	—	—	0	0	0	0	0	0	0	0	0	30	0	0	5	0	0
8. Uig, . .	—	—	—	—	—	—	—	—	—	—	—	—	22	429	*	12	159	*	—	—	—
9. Morsgail,	.	.	.	33	648	*	25	492	*	25	492	*	9	1375	*	94	926	*	86	356	*

* = Number not registered.
— = Shootings not let.
Most of fish got in Uig in 1875 were taken by the net.
... = Morsgail first let in 1879

7 miles. Any one who has seen Harris from the sea, must have noticed what a mountainous country it is; and the name Harris is said to be derived from the Gaelic 'Na Hardibh,' meaning 'the heights.' Several considerable islands belong to the parish of Harris, 7 of which are inhabited, namely, Bernera, Ensay, Killigray, Pabbay, Scalpa, Scarp, and Tarransay. The population in 1881 was 4360. The mountain ridges in Harris culminate in Cleisham (2622 feet). But most of the summits in the deer forest of North Harris are 2000 feet and upwards. The scenery in the deer forest is wild and impressive, and in it are to be found the best lochs and streams in Harris for salmon and sea-trout, such as Loch Scoorst, Loch Voshimid, and Loch Uladale, and the rivers Meavaig, Resort, Halladale, and others. There are no nets on the sea coast of Harris. The rivers and lochs, both in the Lews and Harris, are late, salmon and sea-trout not ascending until the month of July; but they appear at one time to have been earlier, as Martin, in his *Description of the Western Islands*, published more than a century and a half ago, writes as follows of the salmon fishings in Harris:—

> Fresh-water lakes abound in this island, and are well stored with trout, eels, and salmon. Each lake has a river running from it to the sea, from whence the salmon comes about the beginning of May, or sooner if the season be warm.

It is worthy of notice that, not only are the salmon and the sea-trout late in the Lews and Harris, but likewise the deer and the grouse. The author of *Twenty Years' Reminiscences of the Lews* tells us that 'stags are 'not fit to shoot on Lews, as far as heads are concerned, until at least a 'month after the mainland—the same with grouse.' As regards grouse, however, there is this compensation that they don't pack and may be shot over dogs to the end of the season.

After passing the first shooting lodge on the Harris ground, the road is for a long way very steep. The last lodge on the Lews ground and the first on Harris are not above a mile apart; both being situated on the shores of Loch Seaforth, which penetrates the Harris and Lews land for fully 13 miles. On the descent towards Tarbert Hotel in Harris, I noticed that dams and sluices were being placed at the outlet of two lochs belonging to the basin of the Ballanachist River, and that cuttings had been made in the rocks below, with the view of enabling salmon and sea-trout to surmount the falls farther down the stream.

Next day, in company with Mr Hornsby of the Tarbert Hotel, and Malcolm Macaulay, the Ground Officer and Head Fisherman, I drove up to inspect the lochs where I had noticed the dams and cuttings the evening before. The lochs are two in number, consisting of Loch-na-Morcha, which is fully a mile round, and a smaller loch further down. A pretty bay 3 miles from Tarbert Hotel leads up to the mouth of the Ballanachist River, and salmon come in considerable numbers to the foot of the first waterfall which is about 20 feet high. The embankment at the outlet of Loch-na-Morcha is composed of stones and turf, and is very solid and substantial. It is fully 6 feet high and 120 feet in length. At the sluices, it is 12 feet in thickness. There are two sluices occupying an opening 6 feet by 6. At the outlet of the lower loch the sluices are put up, but the embankment is not yet completed. Between these two lochs, there is a small lochan or enlargement of the stream, which would form a nice lie for salmon and a good cast, if they were enabled to ascend to it. The highest cutting made in the stream is about 50 yards in length, and the lowest and most important one, which is intended to enable fish to pass round the principal fall, is 350 yards long. Both are situated below the wooden bridge on the high road. Between the sluice at the outlet of the lower loch, and the uppermost cutting, several pools

might be advantageously made in the stream, particularly in a narrow gorge with a high rock on one side. The length of the river from the lower sluice to the sea is a little over a mile. Great skill and ingenuity have been displayed in making the cuttings which have been carried out under the superintendence of the Ground Officer, without the assistance of a regular engineer. Something, however, still remains to be done in the lower cutting. Some of the runs are too long and have too much white water in them, and the top of one of them should be hewn or blasted out. A number of nice resting-pools have been formed in the course of the cut. There should be a large pool made close to high-water mark. I was informed that it is intended to net salmon in Loch Tarbert and carry them up to the lochs, so that they may breed in the streams, and the smolts come down to the sea. These lochs are outside the Deer Forest, and I understand that it is intended, in the event of the efforts made to bring salmon and sea-trout up to them proving successful, that they shall be attached to the Tarbert Hotel fishings, which at present comprehend only the Lacastile Lochs. Since the above was written, I have had the pleasure of receiving a letter from Mr Hornsby, dated 27th January 1886, stating that the improvements above suggested have now been carried into effect, and that the result has been to give salmon and sea-trout free access into the streams above the fall and the two lochs beyond. He writes as follows :—

About the Ballanachist work, it has turned out a complete success. In one cut in the river near the middle, inspected by you and altered as you suggested, there were counted 57 salmon ascending in half-an-hour. Two of that number were washed on the bank by the force of the stream. We are still engaged in altering the bed so as to make it more easy for the fish. The lower pool, also suggested by you, is a most complete success. Had I allowed the river and lochs to be fished, I am certain we would have taken over 500 salmon. The river at one time got low, and left 23 salmon high and dry. We secured them and took them up in tanks to the upper loch (Loch-na-Morcha).

This is certainly a most gratifying result, especially when it is considered that salmon and sea-trout have been enabled not only to pass a waterfall 20 feet high but also to ascend a rocky rapid stream running over a steep hill side and to reach the lochs beyond, by works designed and carried out by an experienced practical fisherman, thoroughly acquainted with the habits of salmon, but without any engineering education. From the statement, however, that two salmon were washed out of the cut on to the bank, it would seem as if the gradient were still too steep; and it would probably be an improvement to form a resting-pool for the ascending salmon about the middle of the cut. The cost of these works has been moderate when contrasted with the results obtained; the whole expense of carrying out the original works and making the alterations suggested by me having been only £169.

Meavaig River.

After leaving the Ballanachist River I drove to the Meavaig, a salmon stream entirely in the Deer Forest, flowing out of Loch Scoorst, one of the best salmon and sea-trout lochs in Harris. Both river and loch are late, and when I inspected them in the end of June there were no salmon up. The Meavaig is about the size of the Creed, near Stornoway. It was not in good fishing ply when I saw it, the water being very low. Loch Scoorst is about 2 miles from the head of Loch Meavaig, a branch of West Loch Tarbert. It is a mile and a half in circumference, and on the right side looking up the glen it is overhung by a magnificent rock,

apparently about 1000 feet high. Wonderful sport has occasionally been got in this loch. Macaulay, the Ground Officer, told me that in August 1842, without a boat and fishing from the side, he captured in one day 19 salmon and a number of sea-trout, the whole take weighing 180 lbs. This is the greatest angling feat on record in Loch Scoorst. But, 5, 6, 7, and 10 salmon have been caught in it by one rod in a single day. Macaulay has known the Harris fishings since 1828, and he says that 50 years ago, there were 20 salmon for 1 there is to-day. He thinks Loch Voshimid from which the Resort River—the largest in Harris—flows, even a better loch than Loch Scoorst. The average annual take of salmon and sea-trout by the rod in the North Harris rivers and lochs for the last 13 years, has been 50 salmon and 700 sea-trout, most of the latter large. In 1883, 70 salmon and 750 sea-trout were captured. This includes only the salmon and sea-trout taken within the limits of the North Harris Deer Forest, and does not include those captured in the lochs attached to the Tarbert Hotel, or in the streams and lochs of South Harris. The annual average of the Hotel fishings, Mr Hornsby informs me, is 32 salmon and 632 sea-trout, of smaller size than those caught in the forest lochs; and he thinks that probably half as many more are taken by yachtsmen with nets and by other kinds of poaching. I have no return of the numbers caught in South Harris. In various parts of Harris, salmon and sea-trout take the fly in the sea, and Macaulay told me that he has known 15 salmon taken in the bay at Avonsui by a gentleman staying there. The fly used was dressed by Macaulay, and had a green body with flat silver tinsel and herons wings. Many years ago, when fishing in Harris, I killed 8 sea-trout with fly in the sea near the mouth of the stream that runs out of the lowest of the Lacastile Lochs; and the same season I got several heavy sea-trout with the Protean minnow in the bay into which the Laxdale River runs. On this latter occasion, salmon were jumping all round the boat. But, though the sea-trout were taking the bait freely, no salmon ever offered to take it, and I have been often puzzled to find out a reason for this. Why is it too that sea-trout, and occasionally salmon, will take fly, or worm, or minnow, in various places in the Outer Hebrides, and in the bays and voes of the Orkney and Shetland Islands, and almost invariably refuse them in the bays and creeks around the shores of the Mainland of Scotland?

Loch Voshimid.

Next day I drove to the bridge over the Meavaig River, and from thence walked to Loch Voshimid, a distance of about 5 miles, passing Loch Scoorst and the Meavaig River by the way. The upper part of the Meavaig which flows into Loch Scoorst contains splendid spawning ground. Loch Voshimid is larger than Loch Scoorst, and the river that flows from it—the Resort—has considerably more water than the Meavaig, and has some good pools not far below the loch. The gillie who was with me remembers the fishings in Harris for 25 years. He thinks there are not now as many salmon and sea-trout as there used to be. There is a good deal of poaching; and when asked whether there was not as much poaching 25 years ago as there is now, he replied that the poachers then were not so well up to the ways of taking salmon as they are now. They know exactly where the salmon lie in close-time, and they use nets and drive the fish into them. A bothy should be constructed between Loch Scoorst and Loch Voshimid, and a keeper should sleep there in winter, during the close-time to watch the rivers. On the other hand, it should be mentioned that Macaulay, the Ground Officer, says that there is no poaching in the forest.

Avonsui.

On the 26th of June I drove from the Tarbert Hotel to Avonsui, the residence of Lady Scott, in Harris. I write the name as it is pronounced, but the spelling in the Ordnance Map is Amhuinnsuidhe. There are two rivers here, one of which rises in Loch Ashaval; flows through two considerable lochs, each about a mile long; then traverses two much smaller lochs; and finally falls into a sea-loch termed Loch Leosavay, close to the Castle at Avonsui. It is somewhat larger than the Meavaig River, which flows out of Loch Scoorst. Of the lochs through which the river flows, the two smaller ones are the best for salmon, and the large loch above is very good for sea-trout. In one of the smaller lochs, 14 salmon have been taken by one rod in a single day. Another small river—the Halladale—runs into Loch Leosavay on the west side. There are two small lochs connected with its basin—Loch Langavat and Loch Halladale—to both of which salmon and sea-trout have free access. At low water, the Avonsui falls over a rock into Loch Leosavay, in which salmon are said to take the fly readily. Cuttings have been made in the rock with much skill in order to facilitate the passage of salmon and sea-trout into the numerous lochs belonging to the basins of the river, and these operations have been attended with much success. I think, however, that it might be advisable to have a wider and deeper resting-pool just above the rock over which the stream falls into the sea at low water; and the resting-pool a little higher up should be widened. There is too much white water in it at present. Macaulay, the Head Keeper at Avonsui, whose name figures frequently and advantageously in the pleasant pages of *Twenty Years' Reminiscences of the Lews*, thinks that the rod-fishing in Harris should close on the 15th October instead of on the 31st. He says that the fish are quite out of condition after the 15th and ready to spawn. Both the Head Keeper and his brother the Ground Officer, whose experience of the fisheries is varied and extensive, are agreed that, 40 years ago, there were 20 salmon in Harris for 1 there is now. But they cannot state the cause of the decrease.

Loch Resort, which is about 7 miles long, divides Harris from Lews on the west, and receives the waters of two rivers which flow into its head—the Resort from Loch Voshimid and the stream from Loch Uladale. These, the chief affluents of the loch, are entirely Harris rivers, and the principal run of salmon and sea-trout from that sea-loch naturally press upwards to ascend these streams. On the Harris side of Loch Resort, there is no netting, but the keeper at Avonsui alleges that a sweep-net which is worked on the Lews side of the loch by a lessee of Lady Mathieson's, intercepts the majority of the fish trying to find their way into the Harris rivers. This he states, arises from the fact that the Harris side of the head of the loch is shallow while the Lews side is deep, and, on the latter, is the chief run of the fish. There is a rock in the centre of the channel, one half of which belongs to Harris and the other half to the Lews. But the sweep-net, owing to the deep water channel being on the Lews sides, intercepts the majority of the fish which are Harris fish and bred in the Resort and Uladale rivers. The fishing in this channel, however, seems entirely a matter for private arrangement between the proprietors. The sweep-net is a perfectly legitimate instrument for the capture of salmon within an estuary; and the Lews proprietor is merely availing herself of the fortunate accident which placed the deep water channel on her side of the loch. If the weekly close-time be regularly observed, the fish will have 36 consecutive hours in every week to ascend the rivers without interruption from the net; and the

large takes of salmon and sea-trout in Loch Uladale and Loch Voshimid show that, in spite of the net, a good many of them find their way up.

The Lacastile Lochs.

There are three lochs, called the Lacastile Lochs, about 3 miles distant from Tarbert Hotel, from the lowest of which a small stream flows into East Loch Tarbert. In the latter part of summer and in autumn, these lochs are pretty well stocked with salmon and sea-trout, and visitors to Tarbert Hotel have the privilege of fishing in them. There is, however, a waterfall on the stream, which, though by no means a total obstruction, is, to a certain extent, an impediment to the upward progress of the fish. It is a broken fall between 6 and 7 feet in height, but on the left bank, there is a sort of natural salmon-ladder which looks as if attempts had been made to improve it by artificial means. The ascent of salmon would certainly be facilitated by making a subsidiary dam a little way down the stream; removing a sharp block of stone near the foot of the natural salmon-ladder; deepening the pool just beneath where the run up the broken water commences; and turning a streamlet of water, which at present dribbles through the rocks, into the channel that leads into the above-mentioned pool. This little river is only a few hundred yards in length between the lowest of the Lacastile Lochs, from which it flows, and East Loch Tarbert into which it falls; yet it has several nice looking pools. But Mr Hornsby, of the Tarbert Hotel, says that fish scarcely ever rise in them, but press right upwards towards the lochs. These lochs are connected with one another by small streams. The loch nearest the sea is the smallest and shallowest, but is the best for salmon; the middle loch is somewhat larger and deeper; and the uppermost loch is larger than the two others put together, being quite a mile long. It is also the best for grilse and sea-trout. Its surroundings are singularly picturesque, so that it possesses almost as many attractions for the sketcher as for the fisherman. About 15 years ago, a friend and myself captured in four days fishing, in the month of August, 48 sea-trout—one or two of them 4 lbs. weight—and a couple of grilse in this loch. But I understand that the angling is scarcely so good now as it was then.

The streams and lochs in South Harris are not so productive as those in North Harris, though some of them yield very fair sport. Two large lochs, called the Obb Lochs, afford the best angling; and in autumn the sea-trout in them are both numerous and heavy. A stream runs out of Loch Langavat, the largest lake in South Harris, into the head of the Obb Lochs. It is remarkable for the crystal purity of its waters; pools 6 or 8 feet deep appearing scarcely deeper than one's knee. In the Obb Lochs and in this stream I took, some years ago, a number of fine sea-trout, and I understand the fishings, which are strictly preserved, are as good as ever. Salmon are said to rise to the fly in the bay near the mouth of the stream that flows from the Obb Lochs.

The number of lochs in the Long Island, whose name ends in vat (the Norwegian '*vatn*,' water), is remarkable, and is one of the many traces of the Scandinavian rule that once extended over all the Western Islands, from the Butt of Lews to the Isle of Man. In Lews, Harris, and Benbecula, there is a Loch Langavat (long water), in each case the largest lake in the island, and besides that we find Ollevat, Steepavat, Grunnavat, &c. The number of names of rivers and lochs too in which the Norwegian '*lax*' (salmon) occurs is noticeable. In the Lews there are the rivers

Laxadale and Laxay, and Loch Laxay; and in Harris two streams named Laxadale and the Laxadale Lochs.

NORTH UIST.

North Uist is separated from Harris by a rocky and dangerous channel 7 miles wide, thickly studded with islands and islets, called the Sound of Harris. North Uist measures 16½ by 13 miles, and has an area of 68,000 acres. The chief place in it is Loch Maddy, situated on the sea-loch of the same name, whose winding shores indent the land in every direction; so that, when driving in the neighbourhood, you are surprised to see branches of this ubiquitous loch ramifying in the most extraordinary and unexpected directions. Another sea-loch, called Loch Eport, has almost as remarkable sinuosities as Loch Maddy, while the fresh water Loch Scadoway rivals both of them in variety and eccentricity of outline. On the eastern side of the island the land rises into a low ridge which gradually increases in elevation towards the south-eastern corner, and culminates in Eval 1138 feet, the highest point in North Uist. Proceeding westwards from Eval, a large almost level tract of land presents itself, occupying nearly half the area of the island. This is so dotted over with lochs of all sizes that it is difficult to say whether land or water predominates. The entrance to Loch Maddy, a safe and well sheltered harbour, is marked out to mariners by two remarkable rocks, Maddy More and Maddy Grisioch. The word Maddy means dog. These rocks are formed of basalt, and the larger of the two is nearly 100 feet in height. They are the only basaltic rocks that occur in any part of the chain of the Long Island. In the beginning of last century, Martin writes as follows about Loch Maddy:—

This loch hath been famous for the great number of herrings taken in it within these 50 years past. The natives told me that in the memory of some yet alive, there had been 400 sail loaded in it with herrings in one season; but it is not now frequented for fishing, though the herrings do still abound in it; and on this coast, every summer and harvest, the natives sit angling on the rocks, and as they pull up their hooks, do many times bring up herrings. That they are always on the coast appears from the birds, whales, and other fishes, that are their forerunners everywhere; and yet it is strange that, in all this island, there is not one herring net to be had; but if the natives saw any encouragement, they could soon provide them. Cod, ling, and all sorts of fish taken in these islands, abound in and about this lake. . . . . . It also affords a good quantity of oysters and clam shell-fish; the former grow on rocks, and are so big that they are cut in 4 pieces before they are eaten.

Of the island generally, the same writer says:—

There is such a number of fresh water lakes as can scarcely be believed: I myself and several others endeavoured to count them, but in vain, for they are so disposed into turnings that it is impracticable. They are generally well-stocked with trouts and eels, and some of them with salmon; and what is yet more strange, cod, ling, mackerel, &c., are taken in these lakes, into which they are brought by the spring tides. These lakes have many small islands, which in summer abound with a variety of land and sea-fowls that build and hatch there. There are also several rivers here which afford salmon; one sort of them is very singular, that is called marled salmon, or, as the natives call it *ieskdruimin*, being lesser than the ordinary salmon, and full of strong large scales; no bait can allure it, and a shadow frights it away, being the wildest of fishes; it leaps high above the water and delights to be on the surface of it. There is great plenty of shell-fish round this island, more particularly cockles: the islands do also afford many small fish called eels, of a whitish colour, they are picked out of the sand with a small crooked iron made on purpose. There is plenty of lobsters on the west side of the island, and one sort bigger than the rest, having the toe shorter and broader.

I have no idea what this 'marled salmon,' described by Martin can be. He afterwards mentions it as being likewise got in Benbecula. But I found no trace of it in any of the islands.*

At Loch Maddy, I was fortunate enough to be the guest of Sheriff Webster, whose acquaintance with the fisheries in North Uist is varied and extensive, and who is himself an accomplished practical angler; and I had the advantage of visiting the principal lochs and streams in the island in his company. Not far from Loch Maddy is Loch-na-Ciste, or the Loch of the Cruive, which communicates with the sea, and where there is a cruive-dyke in which there was formerly a cruive-box. The tide flows freely into this loch, so that salmon and sea-trout have access not only into it, but likewise into Loch Skealter—into which the largest stream in North Uist flows—and thence into Loch-na-Garb-abhuinn into which another considerable stream runs from the maze and labyrinth of waters called Loch Scadoway. In fact, through Loch-na-Ciste, salmon and sea-trout have access to between 3000 and 4000 acres of fresh water lochs. The ramifications of Loch Scadoway are intricate beyond conception, and yet its waters are all discharged through three comparatively narrow archways passing under the high road. I can easily conceive, therefore, that even the instinct of the migratory salmonidæ, who have found their way into it, may be insufficient to extricate them, until a late period of the year, from this watery wilderness. Sheriff Webster and the game-keeper, both accomplished anglers, and thoroughly acquainted with the habits of the salmonidæ, assured me that they had caught kelts belonging to this great watershed as late as the month of August. No doubt, they had been unable to find their way down to the sea sooner. There are scarcely any spawning streams running into Loch Scadoway, and most of the fish spawn in the river running out of Loch Scadoway and in that flowing into Loch Skealter. So far as the angling is concerned, it would certainly be advisable to build a dam with a sluice at the head of the river that runs out of Loch Scadoway, or to put up a grating to prevent the ascent of salmon and sea-trout into Loch Scadoway, where no one catches them and where they are of no use to anyone. There are numerous lochs in the mountainous part of North Uist. But the trout they contain are not nearly equal in size or quality to those found in the Machair or Meadow district where the feeding is better. The sea-trout in this western portion of the island are also larger and fatter than those found in the chain of lochs connected with Loch-na-Ciste.

On the 30th June, I drove nearly round the island, in company with Sheriff Webster. We first stopped at Mullanageren where there is a mill near the mouth of a stream, which has a course of about 200 yards from Loch-na-Geiran, a fine large loch with shingly and sandy shores. But the lade connected with this mill is so managed at present, that it is quite impossible for any salmon or sea-trout to get up to the loch, though it is so close to the sea. The foot of the loch is dammed up, and the water which should be discharged into the natural channel of the burn is diverted into the lade, and, when the mill is not working, is sent through a wooden shoot, from which it issues in a perpendicular fall of at least 6 feet perfectly insurmountable by any fish. Then, even when the sluice leading into the channel of the stream is opened, the passage below is choked by great blocks of stone, so that no fish can get up, even when the water is sent down the channel of the burn through that sluice.

* Since the above was printed, I sent Martin's account of the 'marled salmon' to Sheriff Webster at Loch Maddy, and he replies as follows :—'I will tell you what I 'believe to be the "marled salmon," viz., the "grey mullet." The description 'given exactly tallies with its appearance and habits here. I have shot them several 'times when running away in the shallow *tidal* lochs.'

To remedy this, a sluice should be constructed on the right bank of the lade, a little below the intake. When the mill is working—and I was informed that it does not work above a month in the year—this sluice should be kept shut, and the water sent down to the mill wheel. But, when the mill is not working, the sluice should be opened, and the water should be discharged into the channel of the burn which should be cleared out and deepened. A considerable body of water, quite sufficient to bring up sea-trout, if not salmon, would thus be sent down to the sea whenever the mill was not working. In this way, the working of the mill would not be in any way interfered with or injured, whilst the migratory fish would be enabled to reach the loch, which they have not a chance of doing, as matters at present stand. Two large burns, which drain an extensive hillside and a wide flat moor, flow into Loch-na-Geiran.

Cockles in North Uist.

After leaving Loch-na-Geiran we passed Vallay where there is an extensive sandy bay abounding in cockles of large size and fine quality, which, however, so far as I could learn, are not by any means utilized as they might be. These cockles are gathered and used for food by the people on the spot, but they are not gathered for exportation and sale. The facts with regard to them are thus described by the minister of Vallay in 1837:—

> The great resource for sustenance, particularly in a season of scarcity, is the cockle, which is found in inexhaustable abundance on the sands, where, on the retiring of the tide, hundreds of the people are seen collecting them. They are an excellent and nutritious food made up into stews with some milk and with a little bread. They form a principal part of the diet of poor people in seasons of scarcity. As an article of luxury they form an excellent sauce with fish of every description; and used raw, they are little inferior to oysters. Besides this valuable shell-fish, there are razor-fish, spout-fish, whelks, mussels, limpets, and in parts, lobsters, clams, &c. The cockle, besides its importance as an article of food, is of importance in some manufactures. Its shell, when burnt gives the best lime known. In strength it is superior to any other, and in whiteness it vies with snow itself.

At a place called Paible, there is a strand considerably larger than that at Vallay, where cockles are found in great abundance, and where, likewise, they are not utilized as they might be.

I can personally corroborate what is above stated with regard to the excellence of these cockles as an article of food, as I have tasted cockle soup at Sheriff Webster's residence near Loch Maddy, scarcely inferior to oyster soup; and now that oysters have become so dear, cockles, such as those to be found on the shores of these western islands, would form no bad substitute, if they could be carried to a market in good condition. How valuable they are when near a market, the following extracts from the Report of 1879 on the Sea Fisheries of England and Wales, by Messrs Buckland and Walpole, will clearly show :—

> Few people are probably aware of the value of the cockle industry. No less than 2263 tons, worth £11,000, were sent away in 1877 from the stations on the north side of Morecambe Bay. In addition, it is estimated that one-third of the entire take is consumed in the neighbourhood. The cockles, therefore, taken every year on the north side of Morecambe Bay alone must weigh over 3000 tons, and be worth over £16,000. We believe that we are within the mark in saying that the cockles from the south side of the bay are worth more than £5000 a year. It follows, therefore, that the value of this little mollusc to the Morecambe Bay fishermen cannot be less than £20,000 annually. Yet from the inquiries we have made in Morecambe Bay, we are unable to trace

any decrease in the yield of this fishery. We believe that the yield in Carmarthen Bay and in the Wash is equally sustained.

To the above I may add, from the same Report, that from 600 to 700 people and 100 carts are employed in collecting cockles in Morecambe Bay alone.

Barra seems to be the only one of the Outer Hebrides where they carry on a considerable export trade in cockles. Three hundred years ago Dean Monro wrote of the 'Grate sandes of Barray':—

Ther is na fairer and more profitable sands for cokills in all the warld.

And he tells the following curious story of the belief of the Barra people as to the origin of the cockles:—

In the north end of this ile of Barray ther is ane round heigh know, mayne grasse and greine round about it to the heid, on the top of quhilk ther is ane spring and fresh water well. This well treuly springs up certain little round white things, less than the quantity of ane confeit corne, lykest to the shape and figure of ane little cokill, as it appearit to me. Out of this well runs ther ane little strype downwith to the sea, and quher it enters into the sea, ther is ane myle braid of sands, quhilk ebbs ane myle, called the Trayrmore of Killbaray, that is, the Great Sandes of Barray. This sande is all full of grate cokills, and alledgit be the ancient countrymen, that the cokills comes doun out of the forsaid hill throughe the said strype in the first small forme that we have spoken off, and after coming to the sandes growes grate cokills alwayes.

I find the following interesting statement concerning the cockle industry in Barra, in the 'Scotsman' of 8th January last:—

For some time it has been known that there was a productive cockle bed near the north end of the island of Barra, but it is little more than 12 months since any quantity was gathered and sent to market. A market, however, having been found for the cockles in England, larger and larger quantities were sent off, week by week, by the crofters and others—all and sundry being allowed to gather whatever quantity they chose—until in one week the quantity reached 1200 bags. Something over 10,000 bags have been shipped within the last three months; but the prices have come down very much owing to the enormous quantities sent south, and the net returns to the Barra men would not average much above 2s. per bag. Even this small sum pays the labour well enough, however, and would represent over £1000 brought to the island in the three months. The steamers which conveyed the cockles to Oban and Greenock must have netted more than half that sum as freight, and the various railway companies over £1000 for carriage. The bed has every appearance of containing an almost inexhaustible supply, and it would be, indeed, a valuable mine to the poor islanders, who this year above all others require some means of subsistence besides their crofts, were the steamer communication more frequent. At present, cockles can only be sent away once in 10 days, consequently, enormous quantities are thrown into the market in one day, to the detriment of the senders.

Sea and Loch-Trout at Vallay, the Manse Loch, &c.

There is a large and deep sea-pool in one corner of the bay at Vallay, in which, at certain states of the tide and seasons of the year, there is good fishing for sea-trout.

The manse of North Uist stands close to a beautiful fresh-water loch of about 60 acres, containing fine red-fleshed trout of excellent quality, which have been caught as heavy as $2\frac{1}{2}$ lbs., and are quite commonly a pound weight. There is another capital trouting loch on the glebe.

At Hogary, there is a mill where the passage of salmon and sea-trout to a good fresh water loch is prevented in a manner similar to that which I have described at Mullanageren. In this case, I think that fish would

best be enabled to reach the loch above by means of the lade. Of course a grating would require to be placed between the sluice and the mill wheel, in order to prevent the fish from going the wrong way. The sluice should be put on the left bank of the lade at a point where there is at present a wooden trough through which the water in the channel of the lade passes. At the mouth of the stream running out of this loch, one of the lintels supporting the arch through which the water passes towards the sea has been thrown down by the force of the waves, and so the passage is very much choked up. There is said to be a third mill at Dusary where the entrance to the loch above is barred against migratory fish by the way in which the mill is worked.

The sea-trout in the lochs on the western side of North Uist seem to be of even a larger size than those in the Park Lochs in the Lews, or those in the Forest Lochs in North Harris, as Sheriff Webster told me that he had once killed in Loch-nan-Clachan, 15 sea-trout weighing 49 lbs., and in Loch Horisay, 7 sea-trout weighing $48\frac{1}{2}$ lbs.; the former gives an average of $3\frac{1}{4}$ lbs., and the latter an average of nearly 7 lbs. per fish—certainly a remarkable, and so far as I know, an unparalleled average for sea-trout.

Loch Caravat.

On the 2nd July I drove to Store at the head of Loch Eport, where there is a kelp manufactory, passing by the way a loch which is said to contain a peculiar striped variety of trout. We tried it with fly, but were not able to obtain any specimens. This loch communicates with the sea by a short burn up which trout could easily ascend if they were not prevented from doing so by stones placed at the mouth for poaching purposes. At Loch Eport, we procured a sailing boat and sailed down the loch for 7 miles, finding the wind very squally, especially off Eval, the highest mountain in the island. On landing we walked across the moor to Loch Caravat, the prettiest loch in North Uist, and what is singular in this country of shallow waters, a very deep loch. It has a fine rocky or gravelly bottom for the most part. The banks are everywhere steep and in many places perpendicular. The shores shelve in gradually for a few yards from the edge of the loch, and then dip down at once into very deep water. This would be an admirable loch for trying the land-locked salmon. There is a large expanse of water, great depth, and a fine clean bottom. There are several islands on this loch partially wooded by mountain ash trees, and some of them covered with ferns, the *Osmunda regalis*, or royal fern, being quite common. The foot of the loch communicates with the sea by a short broad burn. But this is entirely barred, and the upward progress of salmon and sea-trout prevented by an elaborate arrangement of rough stone-work, put up by the poachers of a former generation, for the purpose of intercepting the fish on their way to the loch. A passage would require to be cleared through this in order to enable fish to get up. A couple of days' work of two men with levers would clear a way through the stones to the sea. There is a deep pool of salt water close to the mouth of the burn, left by the receding tide. This must contain sea-trout in autumn, at the proper state of the tide.

Sheriff Webster mentioned to me a remarkable circumstance with regard to the run of salmon in North Uist. He says, that the true salmon (*salmo salar*), comes up from the Minch and enters the lochs—such as Loch-na-Ciste—communicating with the Minch; but that no salmon, so far as he knows, has ever been taken in the lochs that communicate with the Atlantic. On the other hand, salmon came up from the Atlantic into

the lochs and rivers on the western side of the Lews and Harris and into the Howmore River on the western side of South Uist. The sea-trout and bull-trout, he also says, run large in the lochs on the Atlantic side of North Uist, while in the lochs on the Minch side they are only of an ordinary size—from half-a-pound to 2½ lbs. The superior size and condition of the sea-trout in the lakes on the Atlantic side, he attributes to the immense quantity of sand eels to be found in the extensive strands at Vallay and Paible.

BENBECULA.

A complicated, shallow strait, upwards of 3 miles wide, and fordable at low water, separates North Uist from Benbecula. In foggy weather, or at night, the passage across is dangerous, as the ford is intricate, and there are quicksands, and here and there deep pools left by the tide. Benbecula is of a circular shape and about 8 miles in diameter. Its name is said to be derived from 'Bein-na-faoghail,' meaning mountain of the fords, as it has the ford already mentioned on the north and a narrower ford on the south, between it and South Uist. It has an area of 22,874 acres, and in 1881, it contained 1781 inhabitants. The western side of Benbecula presents a flat sandy shore with a comparatively even coast line, with the exception of one deep indentation. But the eastern side is of quite a different character, and is thus graphically described by Macculloch in his *Western Islands*:—

> The eastern side of the island, and the eastern portions of the northern and southern boundaries are characterized by those tortuous and intricate indentations of the shores which occur in South Uist. But they far exceed these in their capricious sinuosities; forming a labyrinth from which a stranger, attempting to move among them, whether by land or water, is unable to extricate himself. Of these, Loch Uskevagh is the most remarkable, occupying a space of 10 or 12 miles in circumference, in which the land and water are interspersed among each other in such equal proportions and such minute divisions that it is difficult to say which predominates. The visitor who attempts to explore it is unexpectedly surprised by the occurrence of new channels and fresh headlands, when he had imagined himself at the end of his voyage; and in the multiplicity of islands and promontories which open and shut upon him at all hands, loses the recollection of his place and the clue to his return.

There is a comfortable inn at Creagorry, on the south shore of Benbecula, with some good fishing attached to it. There are scores of fresh water lochs spread over the surface of the island, among the chief of which are Loch Langavat and Loch Ollevat. I went with Mr Bain, the landlord of the hotel at Creagorry, to see a mill on a stream which is the outflow of a great chain of lochs, but which, owing to the way in which it has been treated in connection with the working of the mill, is at present quite impassable for sea-trout and salmon. There is a high and strong dam across the foot of the loch and a sluice at the intake of the lade which supplies the mill, and there is, near the wheel, a wooden shoot, through which the water is discharged in a perpendicular fall, just as at Mullanageren in North Uist. No fish can at present get up either by the burn or the lade connected with it. But there is another burn flowing out of the left hand lower corner of the loch, a little choked up with weeds, but still having a considerable body of water in it. This burn passes through an archway under the road leading to the mill; and, a few yards below falls into a bay of the sea. The channel below the road should be cleared out and deepened. Then, in the bed of the burn,

a short distance above the road, there is a waterfall fully 4 feet high, with the pool below almost filled up by a large block of stone. This should be removed and a subsidiary dam should be formed across the stream, about half-way between the fall and the road, with the boulders which are lying close at hand. If this were done, I have no doubt that sea-trout would find their way to the lower loch from which this stream flows, and also to the great chain of lochs connected with it. Labourers can be had in Benbecula for 13s. a week, and I think it probable that a couple of men working for three days would be able to do all that is required.

SOUTH UIST.

The ford between Benbecula and South Uist is only about half a mile wide. Cockles abound both in the great ford to the north, and in the little ford to the south of Benbecula, and mussels, whelks, and spout-fish are also to be got; but they do not appear to be turned to profit as they might and should be, although many of them are gathered for local use. South Uist has an area of about 110 square miles. It is 22 miles in extreme length and about 7 in extreme breadth. The eastern side is mountainous, rising boldly from the sea, and culminating in a fine range whose highest peaks—Hecla, Benmore, and Carradale—are upwards of 2000 feet in height. The western side is a sandy flat of varying breadth, diversified by numerons lochs, but in many places producing good pasture and fair crops of oats, barley, and potatoes. In 1881, the population was 6078, of whom 5842 were Gælic speaking people. Various arms of the sea penetrate deeply into the land on the east side of the island, the principal of which are Lochs Skiport, Eynort, and Boisdale. Fresh water lochs are numerous, both in the mountainous and moorland district on the east and in the long sandy flat on the west; and, as in North Uist, the trout in the moorland lochs are far inferior in size and quality to those in the lochs in the machair or meadow district, in which the feeding is better and more varied. The largest fresh water loch in South Uist is Loch Bee, which is about 3 miles long by 1 broad. It is a shallow loch not exceeding 2 fathoms in the deepest part. At spring tides the sea has access to it, and it contains flounders and mullet in addition to trout. The next largest sheet of fresh water lies a little to the north of Hecla, and is called Loch Druidibeg. It has winding irregular shores and several islands where gulls and other wild birds make their nests. The drive from the north point of South Uist to the comfortable and well kept inn at Loch Boisdale is somewhat dismal and uninteresting, the dreariest part of it being the 3 miles nearest Loch Boisdale, where you pass through a brown barren flat, with nothing to relieve its monotony. The lochs and streams in South Uist are very late, later than in the Lews and Harris; the migratory salmonidæ not making their appearance until the middle of July or even later. About a mile from the hotel, there is a loch communicating with the sea called Loch-a-Bharp, where in the autumn there is good sea-trout fishing; and the Bornish Lochs, 7 miles off, contain fine yellow trout and sea-trout also in the season.

The Howmore.

The Howmore is by far the best river in South Uist, and is quite a phenomenal little stream at the right period of the year and with the water

in good fishing ply. I fished it in 1871 during two afternoons, along with a friend, and we got 60 sea-trout or rather bull-trout, some of them fully 4 lbs. in weight. I have heard of fish of 15 lbs. being caught in it, though I never saw them. But any expert could easily tell from the shape of the gill-cover and other signs, whether these large fish are salmon or bull-trout. Salmon, however, appear to frequent the river, as John Lamont, who has been in charge of the Howmore for many years, gives the following information regarding it :—

> I have seen, in one day, 1765 lbs. of fish taken out of one pool by one haul. I have seen, between 10 a.m. and 4 p.m., 12 or 15 fish caught with one rod ; each fish weighing between 3 and 8 lbs. The system of protection in South Uist is efficient. The watchers are employed and paid by the proprietor. There are no stake and bag-nets. The chief run of salmon and sea-trout is about the middle of July, sometimes earlier and sometimes later. The main take is salmon.

Shortly after my arrival at Loch Boisdale, I drove 12 miles to inspect the Howmore. I went down the north side of the stream from the high road and crossed a wooden bridge near the sea where the entrance to the river is very narrow, and where you might easily count the fish running up. They ascend at times in great shoals, and I was told that John Lamont, the old keeper, had on one occasion, counted their numbers, which amounted to 1200. A little above the bridge, the Howmore is joined by the stream from Loch Druidibeg, which, before its junction with the Howmore, winds very much, and is deep and still. The Howmore itself above the junction forms a number of broad deep pools, the favourite haunts of sea-trout, which may be taken in great numbers with the fly, especially after spring flood tides. The river narrows above the pools near the sea, but continues deep and still till a little way beyond the bridge crossing the high road. Then its bed becomes stony and rocky for some distance with a considerable fall, and with no good spawning ground. Beyond this there is a long stretch—quite half a mile—of deep still water, which should be first-rate for sea-trout in the end of the season. A little higher up, where the river takes a sudden bend at right angles, there is a considerable stretch of good spawning ground, and then the channel becomes rocky again.

The Ruglas.

On the 7th of July I drove from Loch Boisdale to Milton Farm, one of the chief farms on the flat western side of the island. The smooth green turf above the sand was bright with daisies, as I walked down towards the mouth of the little river Ruglas along with Mr Maclean the farmer. The Ruglas rises in Loch Singisclet; passes through, or is connected with 5 other lochs, the chief of which are upper and lower Kildonan and Loch Squirb, the last named being scarcely a mile from the sea; and finally discharges itself into the Atlantic through an artificial tunnel, or covered way, 80 yards in length. Formerly, it fell into the sea through a natural channel a little to the north of the tunnel which was constructed in order to prevent the flooding of the machair or meadow land. There can, I think, be little doubt that a large number of the sea-trout that are pressing upwards towards the fresh water, in the latter half of July and during the autumn months, are unable to reach it on account of this long dark narrow tunnel. But if an open cutting were made, beginning at a point 25 yards below the bridge over the Ruglas, and continued down to the sea, a little to the northward of the tunnel, following the old bed of the river, I have no doubt that ten sea-trout would

ascend for one that does now. I walked up the banks of the Ruglas, which has the second largest drainage area in the island, coming next to the Howmore. There is good spawning ground in its bed, and I saw both trout and flounders in it, the latter having come up from the sea through the tunnel, which, of course, cannot be interfered with as it protects the machair land from floods; but there can be no possible objection, except that of expense, to making the open cutting which I recommend. Between 40 and 50 years ago, when the river flowed in its own natural channel, the Ruglas and the lochs connected with its basin produced far more sea-trout than they do at present; and a man still living in the neighbourhood remembers having seen a couple of cart-loads of sea-trout taken by the net from the lower Kildonan Loch—the loch nearest the sea—and carried to Milton Farm.

The Rev. Alexander Campbell, formerly Roman Catholic priest at Bornish, who has lived for many years on the island, told me that he remembered the Ruglas as a boy. It is about 20 years since the tunnel was made. The tunnel and the straightening and altering the natural course of the river have ruined the fishing. The old mouth of the river joined the sea a little to the north of the present mouth. At one time, before these two operations had been carried out, the Ruglas was almost as good a river as the Howmore. Not one sea-trout now comes up for a dozen that used to ascend. He thinks that if the open cutting to the north of the tunnel were made, as suggested, it would certainly effect a very great improvement in the fishing. It would cost about £50. He remembers a great haul of fish taken from the Ruglas by the net many years ago. The tacksman at Milton had the fishings on the river at that time at a very cheap rate.

The Strome.

In the evening, a gentleman staying at the Loch Boisdale Hotel, brought in from a place called the Strome, a basket of 15 trout, weighing 18 lbs., caught chiefly in the salt water in the ebb stream flowing below a concrete dike, built across a narrow salt-water channel, one of the numerous ramifications of Loch Boisdale. These were all yellow trout, with the exception of 3 finnocks, or small sea-trout. One of the yellow trout weighed $5\frac{1}{2}$ and another 3 lbs. This remarkable circumstance of such fine yellow trout having been caught in the salt water, determined me to go and inspect the place, which I did the next day in company with the gentleman who had had so good a days sport. The Strome is about 3 miles from Loch Boisdale, the shortest road being to walk across a rough marshy moor. At Strome, a lofty dike or dam of concrete, with sluices in it, has been erected across a narrow arm of Loch Boisdale, into the head of which a stream, called Am-lige-Mor, flows out of a large fresh water lake, termed Loch Allan. It is as large as the Ruglas, and there is splendid spawning ground upon it, between the head of the Strome and the sluices on the road from Loch Boisdale to Pollachar. Near Pollachar, there is a small but good trouting loch, called Loch Kilbride, with a short stream running from it into the sea at Salliwick Bay. This stream is at present very much choked up but might be easily cleared out. It is only at certain times of the tide that trout will take at Strome, and we arrived much too early, and walked up to the sluices on the stream about a mile above the concrete dam. This stream and the narrow salt water bay into which it falls are said to fish best during the flood. On the way back I tried the salt water, in a narrow place where the tide ran strongly between a small island and the shore, and got 2 yellow trout and afterwards a lithe. We got back to the concrete dike about the commencement of ebb, when the ebb stream

begins to flow strongly outwards through the sluices, at which period, and for some time afterwards, the fishing is said to be at the best. The concrete dike which here spans the salt water and is used as a bridge by the people in the neighbourhood, is 3 feet wide in the centre, and only 2 feet wide for a considerable distance on each side of the central part. There is no parapet of any kind; and as there is a strong and deep tidal stream running through the sluices and a breach in the dike, just below where you stand, it is not exactly the place for a nervous man to fish from. On the Loch Boisdale side of the dam, a steep rock rises abruptly several feet above the dike, and in this rock there is a narrow nick or cut, rather to one side of the dam, in which you must place your foot and thence spring about 4 feet on to the narrow top of the dike, and if you miss your footing you fall into the deep water on either side. As this dam is used as a bridge by the natives, and a number of women cross it daily in all weathers, it is wonderful that no accident has ever happened. Although the trout had taken so well during the fine weather of the preceding day, we did not find them rise freely in the cold, gusty, showery weather, which prevailed whilst we were fishing from the top of the dam. But we got a few yellow trout, and also a number of lithe. You require to have strong tackle while fishing in this tidal stream, so as to be able to bear hard upon the fish and keep their heads above water, otherwise you will lose them in the sea-weed which abounds in the water below the dam. The yellow trout here are at least half a mile from the nearest fresh water; in water where one would expect to find nothing but sea-fish or the migratory salmonidæ—in fact, I never saw or caught them anywhere else under such circumstances. They were probably what Dr Knox has denominated the Estuary Trout.

Loch-a-Barph.

Next day, when a perfect storm of wind and rain had a little moderated, I went, along with the landlord of the Loch Boisdale Hotel, to inspect Loch-a-Barph, a considerable sheet of water about a mile from the hotel. There is a fine lead for sea-trout from the sea to this loch, the sea flowing as high as a point called Clachan Ardha at ordinary spring tides. A stream runs from the loch into the sea, and four burns fall into it from the neighbouring hills, the chief of which flows out of Loch Stuillival, a loch between 2 and 3 miles in circumference. It was the 9th of July when I inspected Loch-a-Barph, and no sea-trout had yet been caught in it, which shows the lateness of the fishings in South Uist. At times, however, great quantities of sea-trout are found in it, as the Rev. Mr Campbell, already mentioned, told me that, some years ago, 120 large sea-trout—the smaller ones were not counted—were taken out of Loch-a-Barph at a single haul of the net.

Lobster Fishings in the Long Island.

I visited the Long Island in 1876, along with Mr Spencer Walpole, on a Government Inquiry into the Crab and Lobster Fisheries in Scotland; and many of those whom I had met in the course of that Inquiry, and who are intimately acquainted with the lobster fisheries, spoke to me on the subject last summer, especially pointing out that certain provisions of 'The Fisheries (Oyster, Crab, and Lobster) Act, 1877,' which had been passed to carry out the recommendations in our Report, were entirely

ignored and neglected throughout the Long Island; and that, in consequence, the lobster fishery was decreasing in value, owing to the systematic destruction of immature lobsters, which the 9th section of that Act was intended to preserve and protect. That section provides that—

A person shall not take, have in his possession, sell, expose for sale, consign for sale, or buy for sale, any lobster which measures less than 8 inches from the tip of the beak to the end of the tail, when spread as far as possible flat. Every person who acts in contravention of this section shall be liable to a fine not exceeding £2 for the first offence, and £10 for every subsequent offence, and to forfeit all lobsters found in his possession, sold, exposed for sale, consigned for sale, or bought for sale in contravention of this section.

Section 12 provides that—

All oysters, crabs, and lobsters of which the possession, exposure for sale, or purchase for sale, is prohibited by this Act, may be searched for, seized, condemned, destroyed, and disposed of by any authority lawfully acting under any act, charter, or bye-law, or by any persons appointed by that authority, or in Ireland by the Inspectors of Irish Fisheries, with the approval of the Lord Lieutenant, in like manner as if such oysters, crabs, and lobsters respectively were found to be diseased, unsound, unwholesome, corrupt, unfit to be sold, or unfit for the food of man.

All offences against this Act, or against any order made in pursuance of it, may be prosecuted, and all fines recovered in Scotland under 'The 'Summary Procedure (Scotland) Act, 1864.' The above quoted Act of 1877, which prescribes a guage for lobsters, in order to prevent and punish the sale of immature fish, is one of those Acts which, under the 11th section of 'The Sea Fisheries (Scotland) Amendment Act, 1885,' now falls to be administered by the Fishery Board for Scotland, instead of by the Board of Trade; and I humbly venture to think that it would tend much to the improvement and development of the lobster fishery in these islands, if some steps were taken by the Board to prevent the sale of immature lobsters.* It was stated to me several times, that in many parts of the Long Island the lobster fishers were not aware of the prohibitory clauses of the Act of 1877, and that they continued to take the undersized and immature lobsters in ignorance of these clauses; and it was suggested that it might be expedient to print the prohibitory clauses of the Act, in English and Gaelic, and post them up in some frequented and conspicuous place at Stornoway in the Lews; at Tarbert in Harris; at Loch Maddy in North Uist; at Creagorry in Benbecula; at Loch Boisdale in South Uist; and at Castle Bay in Barra. This matter was so often and so strongly pressed upon me in every part of the Long Island, that I trust I may be excused from bringing it thus briefly under the notice of the Board.

THE ISLAND OF MULL.

Mull is the largest of the Hebridean group of islands, next to the Lews and Skye, having an area of 351 square miles or 224,802 acres. Its extreme length is 30 miles and its extreme breadth 29. Its shores are irregular and deeply indented by sea-lochs; and in one place—between the head of Salen Bay and the head of Loch-na-Keal—it is only 3 miles

* Since the above was written, the Board has drawn up and circulated throughout Scotland, by means of its Fishery Officers, a printed notice calling attention to the above mentioned clauses of the Act of 1877, and stating that those who infringe them, after this notice, will be prosecuted by the Officers of the Board.

across in a strait line. There are a vast number of islands, islets, and insulated rocks lying adjacent to Mull, of which the principal are Gometra, Ulva, Staffa, Iona, Kerrera, and Lismore. Its rivers seem at one time, to have contained plenty of salmon. Dean Monro, in his account of the island written nearly 300 years ago, says :—

> In this ile there is twa guid fresche watters, ane of them called Ananva, and the watter of Glenforsay, full of salmond, with uther watters that has salmond in them, but not in sic abundance as the twa forsaid watters.

And Martin, in his description of the Western Islands, published more than a century and a half ago, says :—'There are several rivers in the ile that afford salmon;' while, in the Statistical Account of Scotland, it is stated that 'in all the rivers, salmon, grilse, and sea-trout abound.' The present condition of the Mull Rivers can scarcely be said to bear out these favourable statements. The chief rivers in Mull are the Aros, the Ba, the Forsa, the Lussa, and the Coladoir, and, the principal fresh water lochs are Loch Frisa, Loch Ba, Loch Uisg, Loch Houran, and the chain of lochs belonging to the basin of the Lussa.

The Aros River.

On the 14th July I drove from the Aros Hotel to Loch Frisa. The Aros River does not flow directly from Loch Frisa, but is connected with it by a tributary, a large burn with ample water in it after rain to enable migratory fish to reach the loch. Unfortunately, a little below the point where this burn leaves the loch, and immediately behind the only farm house in the vicinity, there is a considerable water-fall which must prevent the passage into the loch of a great number of the ascending fish. The upper part of the rapid on the left bank of the stream should be blasted, or, better still, a subsidiary dam of concrete should be built across the stream at the point where a paling at present slopes down to the water. This dam should be from 3 to 4 feet in height. Loch Frisa is by far the largest sheet of fresh-water in Mull, being 5 miles long and nearly $\frac{3}{4}$ of a mile wide. The yellow trout in it are numerous and of good quality, but in general small. The landlord of the Aros Hotel, who drove me up to the loch, stated that the fishing in the Aros has greatly fallen off from what it used to be 40 years ago. He said that an old poacher, who died recently at the age of 74, told him that he used, along with others, to spear great numbers of heavy salmon in the Aros and carry them away over the hills. Sea-trout get up to Loch Frisa, but not in great numbers. The lower end of the loch affords the best fishing. The yellow trout on the loch are small—three or four to the pound—but red fleshed and well flavoured. A pound weight is a rare size, and is seldom exceeded. There is much good spawning ground on the Aros. Not being directly supplied by Loch Frisa, it soon runs out after a flood, the River Ba having a great advantage over it in this respect. Another day, I made a careful inspection of the Aros River, walking over the hills till I struck it about 3 miles from its mouth, close to where the tributary from Loch Frisa joins it, and then following its course down to the sea. It has a number of fine rocky pools; and, in the Lews, a river of its size and character would yield annually 60 or 80 salmon and about 300 sea-trout. But the Aros, even in a good year, does not yield a fifth of that number. About 2 miles from the sea, there is a considerable fall which must in certain states of the river, somewhat arrest the upward progress of salmon and sea-trout; but on the left bank there is a very fair salmon-

ladder made by the hand of nature. The Aros and Forsa have no spring run of sea-trout such as there is in the Ba. These fish never ascend them until the end of May or beginning of June. This difference is probably owing to the Forsa having no loch connected with it, and to the Aros being connected with Loch Frisa only by a tributary; whereas the Ba flows directly from a large loch only a couple of miles from the sea.

The Ba and Loch Ba.

From Loch Frisa I drove to the river Ba which flows into Loch-na-Keal after a course of about 2 miles from Loch Ba, the second largest and the most beautiful loch in Mull, lying at the foot of Benmore, and richly fringed with wood on one side. It is about 3 miles long and contains both sea-trout and salmon. The Ba has twice as much water in it as the Aros; and having but a short course from its parent lake, it remains in good fishing ply much longer. It has a spring and an autumn season, sea-trout running both early and late. They are caught of large size in the lake. The Ba has a free clear exit from the loch, being about 40 yards wide where it issues from it. There are some capital pools on the Ba and some good spawning ground. A considerable stream, called the Glencannel River, flows into the head of Loch Ba.

The Forsa River.

The next stream I inspected was the Forsa which falls into the Sound of Mull, at a place called Pennygowan, a mile and a half from the village of Salen. It has a course of about 6 miles and rises in a grand conical-shaped mountain nearly 2,500 feet high, called Ben Talaidh, which dominates the head of Glenforsa. It is larger than the Aros. Between the bridge on the high road and the sea — a distance of nearly three-quarters of a mile—its bed consists entirely of fine gravel, admirably adapted for spawning purposes, and for a mile above the bridge it is equally good. Close to the sea, however, there is a barrier of rocks which crosses the bed of the river and causes a considerable fall. But efforts have been made to do away with this barrier by erecting a concrete dam across the river channel about 80 yards further down. The highest part of this subsidiary dam is 5 feet; and, between it and the fall there is a splendid pool, deep and spacious, and with a strong stream running into its head on the right and the left bank. Near the left bank a cut has been made in the concrete dam, below which there is a pool from which salmon or sea-trout ought to be able to get into the big pool above, when the river is in such a state as to induce them to run. The construction of this cut in the dam is, however, somewhat faulty and should be amended. It is at present turned the wrong way. That is to say the uppermost opening facing the glen is the widest, and the lowest opening facing the sea is the narrowest; whereas it should be exactly the reverse. It is also too narrow, being only between 2 and 3 feet wide. It should be double that width. The rocks on the left hand of the fall appear to have been operated on to some extent, but not sufficiently, and the upper part still requires to be blasted out so as to render the gradient easier. Were this done, I believe that salmon and sea-trout would get easy access to the wide area of valuable spawning ground above. The landlord of the Aros Hotel says that he has never heard of anything great in the fishing way having been done on the Forsa. Yet, as before stated, it is mentioned by Dean

Monro as one of the 'twa guid fresche waters' in Mull which are 'full of 'salmond.' In those days, however, there were probably no sheep drains, and when a spate came down it came down slowly, and the river remained in fishing order for several days, during which fish were running. Now, on the other hand, with the improved system of drainage, rivers rise in a day and fall in a day; so that though the land is better the fishings are worse, and this, no doubt, has something to do with the deterioration of the Forsa. Then too, in these days, the only nets known were net and coble. Stake-nets and bag-nets were unknown, and fish were not stopped on their way up the rivers. The proprietor of the Forsa writes me as follows about that river and the Aros :—

I have seen fish up to 18 or 19 lbs. on the Forsa, and have killed 4 in a day with fly, besides a great weight of sea-trout. They are not so numerous now, but they can get up far easier than before the fall was blasted. We used to spear these small rivers in July and August in bright sunny days, and capital sport it was, once in a way, and very difficult and exciting, and quite as legitimate a way as any other of killing fish *in season.* The laird, tenants, and shepherds used to unite, and it was a very inspiriting sight, and all played the game fairly together with skill, boldness, and courtesy. It was a pity that the law meant to stop night poaching, was so worded as to stop a good old-fashioned Highland sport which is quite fair *during the net season;* and on small rivers you cannot net, and, except in a spate, they won't take fly or bait, so one is not allowed to kill them at all. I made a loch of 12 acres at the head of the Forsa, with nice burns for breeding running into it about 6 miles from the sea, which would have induced many more fish to go up and breed, but it burst twice. It is a place where concrete cannot well be put, and it is the only place where a loch could be made. Regarding the Aros River it would be quite easy to let salmon into Loch Frisa. I cannot understand why the lairds don't join. There is also a fall on the main stream which stops fish. The fishing on the Aros has also fallen off.

It is a great pity that the artificial loch above mentioned at the head of the Forsa gave way. Such a loch, with good spawning burns running into it, is the very thing wanted to improve the river. In my last Report to the Board, I recommended the formation of such a loch on the Glenelg River in Inverness-shire, a stream about the same size as the Forsa.

The Lussa and Coladoir.

On the 16th July, I drove from Aros to Craignure ($14\frac{1}{3}$ miles), and from Craignure to Lochbuie, 15 miles. The latter part of the drive is one of the most beautiful in Mull, from the variety of form in the mountains, the extent of wood, and the picturesque windings of the sea-lochs. On the way I passed the Lussa, the longest and largest river in the island, which falls into Loch Spelve. It is upwards of 8 miles in length. The bridge on the high road crosses it a short distance above its junction with the sea. The proprietors on this river are Mr Guthrie; Maclaine of Lochbuie; and Colonel Greenhill Gardyne. There are falls about 2 miles from the sea; and, above the falls, there are 4 lochs belonging to Lochbuie, the lowest, Loch Sguibain, the second, Loch-an-Eillein, the third, Crumlochan, and the uppermost and largest Loch Airdeglais There is good sport in these lochs. But it is stated by Lochbuie that, although sea-trout and salmon do get over the falls at present, ten times as many would be able to ascend if the falls were blasted and made more easy of access. One side of the falls belongs to Mr Guthrie, and the other to Lochbuie. They are steepest on the Lochbuie side, so that any improvement could be most easily carried out on Mr Guthrie's side. In his answers to the printed queries, Lochbuie writes :—

On the rivers Lussa and Coladoir there are natural obstructions which could easily be overcome with consent of proprietors and money. Magnificent spawning ground above the obstructions.

The Coladoir River is a considerable stream which rises in Loch Houran on the Lochbuie Estate and falls into Loch Scriden on the west side of Mull. Just before reaching Lochbuie the road skirts along a beautiful fresh water lake called Loch Uisg, about 2 miles long; and a short stream admirably pooled and arranged so as to facilitate the ascent of salmon and sea-trout connects Loch Uisg with the head of Lochbuie. Close by the sea stands the picturesque old castle of Moy dominated by Beinbuie, a grand isolated conical mountain nearly 2500 feet in height. The castle is still in pretty good repair though it has not been inhabited since 1740. There are bag-nets in Lochbuie which pay a rent of £300 a year, and the Messrs Macconochie of Lowestoft have established a productive herring and cod and ling fishery in the Bay and the vicinity. Lochbuie, however, states that the want of a telegraph station prevents the proper development of all the different kinds of fishing carried on in this part of the island. At present, the nearest station is at Auchnacraig 12 miles distant. There are sometimes, he says, thousands of herrings lying rotting on the beach for want of the means of telegraphing for a steamer in which to ship them; and in various other ways the fishings suffer.

Lochbuie has a well managed hatchery, and can hatch out 60,000 eggs annually. He had some fine healthy fry of the *salmo fontinalis* and of the Great lake trout of Geneva in his tanks when I saw them. He has put a number of the former into some small lochs situated on the peninsula between Rudha-na-Faoileann and Rudha-nam-Fear. These lochs are about 4 miles from Lochbuie house, and the American brook trout have thriven so well in them that it is now no uncommon thing to get them 4 lbs. weight. They are a very game and free rising fish. A Great Swiss-lake trout weighing $6\frac{1}{2}$ lbs. was taken in one of the Lochbuie Lochs. Lochbuie does not use glass grills in his hatching boxes, but very fine gravel which is boiled before being put into the boxes.* The following account of the hatchery at Lochbuie is given by Mr Barker Duncan, Secretary to the Scotch Fisheries Improvement Association, in a paper on Salmon and Trout Hatcheries in Scotland, read before that Association on 26th November 1884:—

This Fishery was established in 1878. It is the property of Lochbuie. Upwards of 50,000 ova of salmon, sea, and other varieties of trout (*salmo fontinalis*, &c.) are annually hatched. The proprietor, every year, imports eggs from Norway, Germany, Austria, and America. There are large ponds for the reception of fry and for keeping breeding stock. The specialty of the establishment is the breeding and rearing of salmon and sea-trout (spawned from the wild fish caught in the rivers on the property), for the re-stocking of the rivers and lakes on Lochbuie estate for sporting purposes. Large sheets of water on the estate, which were utterly untenanted by fish, now teem with splendid varieties, and afford magnificent sport to the angler. The proprietor not only stocks his own waters, but also sells ova, fry, or grown fish.

Two proprietors of land and of salmon fishings in Mull, both well acquainted, from an experience of many years, with the habits and character of the salmonidæ, have favoured me with answers to the printed queries distributed among those interested in or acquainted with the salmon fisheries in the island. One of these gentlemen writes—

* Since the above was in type, Lochbuie writes me that he has put several thousand fry of the American White Fish (*Coregonus albus*) into Loch Uisg, and that he has also placed fry of the Black and Striped Bass in some of his hill lochs, which have no connection with waters in which there are salmon.

The weekly-close time never has been kept in this district by the bag-nets. One can hardly judge whether it is sufficient. I have sent privately to see bag-nets during several years, and they fish, so far as I can make out, Sunday and Saturday. They have always some excuse for not taking up the leaders. The close-time might be earlier on Saturday, so as to give more time and less excuse for not taking up leaders. There is little difference in take of fish for last 10 years. But there is no doubt that the fish have fallen off in proportion as bag-nets have increased, which was more than 10 years ago. It is the bag-nets and their unfair fishing which has, in my opinion, destroyed the fishing here.

As to the run of fish he writes—

The first clean bull-trout are in March and April. Other sort of sea-trout in April and May. Chief run of salmon, end of July and in August. Salmon and grilse begin to run up Baa River from 20th June to 1st July.

Of District Boards he says—

There was a District Board, but it was impossible to work it, and so it died. I think there are three districts in Mull. One would have been enough; and, in fact, the Lochy District should have Mull attached to it, as all the fish pass Mull on their way to the Linnhe Loch. The most valuable bag-nets in Mull are those which catch passing fish as well as Mull river fish. Mull rivers are small and not of much value comparatively. If the Lochy Board included Mull, they would keep things in better order.

In answer to the question concerning fixed nets, he writes—

I consider that in rocky shores it is fair that there should be bag-nets (I have none myself). I am satisfied that they are useful for the supply of fish to market. But they destroy an unfair share as worked here. They should have a few hours longer close-time, and, at any rate they should be obliged *to repay as much close-time on other days as they take and reap the advantage of by being unable to take up their leaders during the appointed close-time.* They would manage better were that the case, and would suffer nothing. I have known a boat go and see them set when they said they could not get a boat to take up leaders. At present they pay no attention unless they like. *The repaymeut of time is the only fair way to all.*

The other gentlemen to whose answers I refer is a proprietor, both of bag-net and of river fishings in Mull.

He suggests that, in Mull, the last day for rod-fishing, should be the 30th September, instead of, as at present, the 31st October, because the fish come up the rivers to spawn about the first week of October. He is in favour of a close-time for trout from 1st October to 1st April. He also suggests that, in each District, a law should be in force to the following effect, viz., in the event of its being too stormy to take up the leaders on the prescribed days, for the weekly close-time, namely from 6 P.M. on Saturday to 6 A.M. on Monday, that a time corresponding should be fixed during the week for the weekly close-time. There should be only one District Board for the whole Island of Mull, and this Board should have the regulation of all fisheries both in salt and fresh water, including all kinds of shell-fish. The system of protection is at present quite inefficient. There are no watchers whatever. As all District Boards are always deficient in funds, there should be a 10s. or £1 license imposed on every salmon angler, and the monies so collected should be handed over to the Clerk of the Board for carrying on its work. With regard to the meshes of nets, this gentleman is of opinion that the salmon mesh in Scotland (namely three-quarters of an inch from knot to knot, or 7 inches measured round the mesh when wet), is too small. It should be as in England, 2 inches from knot to knot, or 8 inches round the mesh. Numbers of small fish, he says, considerably under 3 lbs. in weight, are oftentimes found hanging in the present meshes. He has himself repeatedly observed this.

This gentleman also adverts to the habitual non-observance of the weekly close-time by bag-nets, and to the systematic poaching for sea-

trout and salmon locally known as 'scringing,' which has terribly diminished the number of sea-trout all along the west coast, especially in the vicinity of Oban, and among the numerous islands, divided by sounds and indented by sea-lochs, where detection is difficult and escape easy.

A well-known tenant of salmon fisheries, he writes, who had been fined several times for having leaders out during the weekly close-time, told the writer that he did not object to being fined, as it paid him well to have his leaders out. There is no one in authority to act in this matter at present, and if no notice is taken of the weekly close-time, naturally, with such a deadly engine as the bag-net, sooner or later, it must exterminate the salmon. It would be advisable, therefore, to have coast guard stations at different points along the coast lines where fisheries are prosecuted. Each station should be provided with a powerful steam launch, in order that the nets may, from time to time, be visited to ascertain if all leaders to bag-nets are, as the law directs, taken on shore every Saturday evening until Monday morning. Should the working of coast guard stations, or water police, be considered, impracticable, gentlemen's gamekeepers (or some other qualified servant) along the coasts where fisheries are prosecuted could, with the consent of their employers, hold a commission either from the Crown or the Public Prosecutor, in order that they may watch over the fisheries. Fishery Boards were appointed in different districts, but few of them now exist. Their powers also were very limited, and—a most important item—they were almost destitute of funds, as a rate levied from the fisheries was found to be unpopular. Consequently, if an individual wished to prosecute an offender, transgressing any of the fishery laws, he had to prosecute the offender at his own expense, which was not always convenient. Perhaps, the simplest manner of raising funds, especially in poor districts, would be to levy a license (similar to that for killing game) upon all fishers for the salmonidæ, whether by rod or by any other engine. Licenses should also be issued (similar to the one necessary for the sale of game). Then make it punishable by law for any person or persons who are not properly licensed to have in their possession for sale, or expose for sale, any of the salmonidæ. The law, as it stands at present, is very defective with regard to the actual possession of salmonidæ. For instance, an individual, or a boat's crew, may have in their possession a boat-load of salmonidæ; you are perfectly helpless to take legal proceedings unless you can swear to having personally witnessed the capture of the fish.

Again he writes about the difficulty of preventing 'scringing':—

How is it possible for one or two individuals to watch, along a beach extending for several miles, some hundred boats scringing for herring or other fish, and so ascertain that no salmonidæ are captured, unless, of course, one had an enormous staff of keepers, which would entail a great expense. Something must be done, and that quickly, or else salmonidæ, which are yearly decreasing, will be a thing of the past, unless the legislation is made more stringent, and when in force, steps are taken to ascertain that the law is properly carried out. It is done in England, Wales, and Ireland, why not in Scotland, where the salmon fisheries are about the most important in the United Kingdom? It is an indisputable fact that for every salmon and sea-trout that is now seen along our coasts and in our lakes and rivers, one saw at least a dozen 30 years ago. The Government should also encourage the establishment of hatcheries for salmonidæ all along our coasts, as this would, in a measure, improve and increase the supply of salmonidæ, for which there is a great demand, both for consumption and sport, and, at present, there is no doubt that the demand is greater than the supply.

As the question of 'scringing' is a vital question for the west coast fisheries for sea-trout and salmon, I beg to repeat here what I had the honour to report to the Board last year, when writing about the fisheries in Argyllshire and the west coast of Inverness-shire, especially as my inspection of Mull has only served to confirm the views which I then expressed.

'*Scringing for Salmon and Sea-Trout on the West Coast.*

'The salmon fishing, and still more the sea-trout fishing in all the Argyllshire rivers, and in many bays and smaller streams, for several miles along the coast, to the north and south of Oban, have been for a number of years past terribly injured by a species of poaching known in this part of the west coast as "scringing." Oban is the great centre of this illegal practice, and it is notorious that nine-tenths of the sea-trout sold in the fish shops, and consumed in the numerous hotels of this beautiful and fashionable resort, during the summer and autumn months, are supplied by the scringers. They themselves have no title whatever to fish for salmon in the narrow seas and in the bays and sea-lochs off the mouths of salmon rivers, nor have they permission from any one who has a title. They deliberately and systematically break the law, and find law-breaking to be a more lucrative practice than the prosecution of their legitimate industry as fishermen for herrings, cod, haddocks, whiting, and other sea-fish. This state of matters has been greatly encouraged by the fact that, until the recent reconstitution of the Board of the River Awe by the Court of Session, there had been no District Board in the neighbourhood of Oban for at least fourteen years previously; so that any watching or prosecution of the scringers had to be carried out by proprietors of fishings at their own risk and expense; and the cost of watching the rivers, bays, and sounds of a coast so deeply indented, and with so many islands, was found to be so great that private persons were unable to undertake it. Several memorials, concerning the evil effects of scringing and the modes of checking it, were addressed to the Home Office and to the Commissioners of Scotch Salmon Fisheries. But no adequate remedy for the evil has yet been found; though it is to be hoped that the newly constituted Board of the Awe, by means of its watchers searching and arresting the boats of the scringers when they come in to the quays at Oban laden with sea-trout illegally captured, may have some effect in checking this species of poaching. The 25th section of "The Salmon Fisheries (Scotland) Act, 1868," which is applicable to it, is about as stringently worded a section as could well be desired. It is in the following terms:—

'In order the better to carry out the provisions of the Act of the 7th and 8th years of Her present Majesty, chapter 95, it shall be lawful for any water bailiff, constable, watcher, or officer of any District Board, or any police officer, to search all boats, boat tackle, nets, or other engines, and all receptacles, whether at sea or on shore, which he or they may have reason to suspect may contain salmon captured in contravention of the said last-mentioned Act, and to seize all salmon found in the possession of persons not having a right to fish salmon, and the possession of such salmon shall be held *prima facie* evidence of the purpose of the possessor to contravene the provisions of the said last-mentioned Act; provided also that the words "the said recited Act," contained in the second section of the last-mentioned Act, shall be read and construed as if they meant and included this Act and the Acts recited therein.

'I have often heard the opinion expressed in Oban and in other localities where scringing prevails, that it is necessary, under this section, for the prosecutor to prove the *locus* where the fish were caught—a thing, in the majority of cases, quite impossible to do. But, with great deference to this opinion, I confess myself quite unable to see any ground for it under the wording of the section, which throws upon the scringers, as clearly and strongly as terms can do, the *onus* of proving that they got the fish legally. Confessedly, they have no right to fish for salmon or sea-trout except *outside* the narrow or territorial seas, as fixed and

defined by 7 and 8 Vict. cap. 95, that is outside one mile measured seawards from low-water mark, and the *onus* is thrown upon them by statute to show that they got them outside the one mile, not upon the proprietors of fisheries or the watchers of the District Board to prove that they were caught *inside* that limit. If, however, it shall be held that this view of the proper reading of the 25th section is incorrect, then the sooner a clause is added to it, to the effect that it shall not be necessary to prove the *locus*, the better.

'The scringers operate with a strong herring net with a deep bag, sometimes fishing from the shore in regular net and coble fashion, sometimes in deep water, having the net between two boats, which make a wide sweep and then come together. They thus contravene the law in two ways—1st, by fishing for salmon and sea-trout without a title or permission from one who has a title; and 2nd, by fishing for and taking salmon by means of a net with a mesh smaller than that fixed by law for nets used for the capture of salmon. So far back as 1870, the evils of this practice of scringing were strongly set before Mr Buckland and myself, then acting as Special Commissioners to report on the effects of recent legislation on the Salmon Fisheries in Scotland; and, in our Report of 1871, we suggested the combination of a number of the smaller Fishery Districts north and south of Oban into larger Districts; the maintenance of one or two steam-launches for purposes of protection; and the assistance of the county police and coastguard to put down scringing. A great deal of evidence was laid before us bearing on the subject, and I may quote the following suggestions made by one of the largest proprietors in the neighbourhood of Oban:—

'I wish to call the special attention of the Commissioners to the system of scringe and splash-net poaching, which prevails to a great extent along the shores of the numerous islands and lochs on the west coast. By the laws already existing this is strictly illegal, but as in using these nets men do not require to land, and as, to obtain a conviction, they must be seen in the act of taking salmon or sea-trout, these laws are, in fact, totally inoperative. In this district I myself have between 25 and 30 miles of sea coast, and to protect this would require a fleet of boats and men out every night, and even that would not be effectual. During the summer months, salmon and sea-trout are openly brought by boats to the quays at Oban and other places nearly every morning for sale, and the only effectual way in which this most destructive system of poaching can be stopped, is by throwing on the seller the *onus* of proving that he got the fish legally. This might easily be done by giving each legal and chartered fishing station a brand or trade mark for their boxes, and to stamp on all receipts given for fish sold, and then giving the police power to seize all boxes not so marked, and all fish for which the seller could not produce the stamped receipt of a legal fishery. This has already been done under the late Herring Acts in Scotland (since repealed), and under the Game Laws in England; and as this sort of poaching is confined chiefly to the west coast, the police on duty at the quays and shipping places would be able to stop the greater part of the illegally caught fish before they reached the market. Of course, the brand or stamp would be a trade-mark, and any person imitating it would be tried for forgery.

'The Lochy District Board, whose District comes within these parts of the west coast which are exposed to the ravages of the scringers, made the following suggestions at a meeting held on 23rd January 1871:—

'The formation of a staff of marine watchers provided with a steam launch to put down the depredations upon salmon committed by trawlers within the southern limits of the district of the River Add and the point of Ardnamurchan.

'This provision is necessary, owing to the prevalence of the capture of salmon by means of trawl and other nets in the waters of the Sound of

Jura and Scarba, Loch Linnhe, the Sound of Mull, and the numerous arms of the sea opening therefrom and adjacent thereto. It is suggested that these watchers should be under the control of a general Board, and the cost defrayed from an assessment to be levied by that Board on all the District Boards rateably within the limits in question. The general Board to be composed of a representative from each District Board. The voting of the representatives and the election of a chairman to be regulated in terms of the 18th section of the Act of 1862.

'The last piece of evidence which I shall quote, bearing upon the subject of scringing, is from a letter from the late Mr Thomas Tod Stoddart, author of *The Angler's Companion to the Lochs and Rivers of Scotland*, which is printed (pages 100–103) in the Report of 1871, by Mr Buckland and myself. He there writes as follows :—

'*Illegal Fishing practised on the Coast of Argyllshire, &c.*—Scringing, as it is termed, with mackerel or herring nets, is largely practised near the mouths of the Argyllshire rivers. In dry seasons, during July and August, when the finnocks and sea-trout show a desire to enter the fresh water and swim about in small shoals close to the shore, ready to take advantage of the first freshet, great havoc is perpetrated among them, and that in a manner openly and without interference, by the coast fishermen. During the two last summers—those of 1868 and 1869, particularly that of 1868—I had many opportunities of seeing how industriously, and with what success, scringing operations were carried on in the neighbourhood of Oban, and also at Salen in Mull, and of judging also how the practice acted to the prejudice of the river fishings in the neighbourhood—those, for instance, of the Awe, the Add, the Nell, the Feochan, the Euchar, the Aros, and the Knock or Baa. Every lawful morning, weather permitting, numbers of those fish were brought into Oban bay by boats ostensibly engaged in the capture of herring, mackerel, lythe, and cuddies, and sold at an underprice through the town. Mr Baird, the lessee of the sea fishings in the neighbourhood, on my asking him why, seeing he had an interest in doing so, he did not interfere and put a stop to the practice, told me if he did so, it was at the risk of having his bag-nets cut and destroyed—the class of fishermen who carried on this system of poaching being both numerous as a body and lawless in their habits. As regards the sea-trout in the Argyllshire rivers, a great falling off in their numbers has of late years been observed, attributable, in a great measure, there can be no question, to this method of scouring their marine haunts.

'When I visited Oban in the course of last summer, I found no diminution in the practice of scringing; and I was informed that there are at Oban and in the neighbourhood eight crews of scringers, averaging four men each. August is, in general, the best month for the scringers. I was told that the boats have often from 50 to 200 sea-trout each. Proprietors of salmon fisheries in the neighbourhood of Oban should be careful of letting any of their fishings to the scringers, or to any persons connected with them; because, if they do, all the fish illegally caught by scringing outside the limits of the regular fishing will be put down to the credit of that fishing, and it will be impossible to touch the poachers under the 25th section of the Act of 1868.

'All the answers I received last year to the printed queries, as to increase or diminution in the take of fish on this part of the coast, agree that a material diminution has taken place, and impute that diminution, in a great measure, to the depredations of the scringers. One answer is, "Takes of fish greatly diminished during last 10 years. I attribute it to "illegal fishing, both on coast and rivers;" a second is, "Diminished owing "to scringing;" and a third, from a considerable proprietor both of lands and fishings in the neighbourhood of Oban, "Very much diminished, "which I attribute to scringing and killing fish on the spawning beds." The remedies suggested are to resuscitate Boards by authority of Sheriff

or Court of Session; that constables, or water bailiffs be employed and paid by the Board to see that all illegal fishing be put down, and illegally killed fish forfeited; that it should not be necessary to prove the *locus* under the 25th section of the Act of 1868, when salmon or sea-trout are killed by unqualified persons; that the county police and the officers and men of the coast-guard may and should be authorised to assist in enforcing the provisions of the 25th section of the Act of the Salmon Fisheries Act of 1868, as was contemplated in a Salmon Fisheries Bill for Scotland, brought in in 1861 by Lord Advocate Moncrieff and Sir G. Lewis, the 62nd section of which provided that—

'The officers and men of the coast-guard service, and the superintendent and officers and men of the county police force, shall have the same powers and privileges as are conferred by this Act on any superintendent and water-bailiffs respectively, for enforcing and carrying into execution the provisions of this Act, and may at all times, when required, by any person having authority under this Act, aid and assist in carrying out the provisions of this Act.

'And that there should be inserted in any future Salmon Fisheries Act a section similar to the 2nd section of the Poaching Prevention Act, 25 and 26 Vict. cap. 114, which has been found extremely useful in preventing game poaching, and which provides that—

'It shall be lawful for any constable or peace officer in any county, burgh, or place in Great Britain and Ireland, in any highway, street, or public place, to search any person whom he may have good cause to suspect of coming from any land where he shall have been unlawfully in search or pursuit of game, or any person aiding or abetting such person, and having in his possession any game unlawfully obtained, &c.'

THE ISLAND OF ISLAY.

I finished my inspection of the salmon fishings in the Inner and Outer Hebrides with the island of Islay, which is the largest and most important of the southern group of the Hebrides. It is 25½ miles in extreme length; 19 in extreme breadth; and its area is 235 square miles or 150,355 acres. The population in 1881 was 8917. The southern part of the island is cleft into two great peninsulas by Loch-in-daal which, opening with a width of 8 miles, penetrates the land for 12 miles in a north-north-easterly direction. It expands into Laggan Bay about the middle of its eastern side; contracts to a breadth of from 1½ to 3 miles in its upper part; and is throughout comparatively shallow for such a wide expanse of water. Islay is less mountainous than any other of the great islands of the Hebridean group, and its soil is much richer, so that it is said that half of its surface might be advantageously subjected to regular tillage. The Laggan and the Sorn are the only salmon rivers of any consequence, but there used to be another, called the Anaharty River, which formerly ran into Loch Gruinnard. But, in consequence of some drainage and reclamation operations, its course was diverted, and it was made to fall into Loch-in-daal. Since then it has been ruined as a salmon river. In his account of Islay, Dean Monro mentions—

Ane watter callit Laxay, wherupon maney salmond are slaine.

This is probably the Laggan. Martin says:—

There are several of the rivers on the island affording salmon. The fresh water lakes are well stocked with trouts, eels, and some with salmon.

Of these lochs the largest is Loch Guirm, about 4 miles in circumference, and the next largest is Loch Finlagan, two-thirds of a mile long by a quarter of a mile wide.

There are no bag-nets or stake-nets in Islay. At one time there were such nets, but the lessee gave them up, as he found they did not pay.

Bowmore Pier.

On the 21st July I drove with Mr Ballingall, factor to Mr Morrison of Islay, to Bowmore, the capital of Islay and the principal port on Loch-in-daal. The bay here, though well-sheltered, is shallow; and at low-water, the present pier is quite dry, so that an extension of it is much wanted in order to improve and develop the fisheries. I saw a plan, according to which it is proposed to carry out a pier upon green heart piles, a couple of hundred yards farther into the bay beyond the end of the present pier. If this plan were executed, there would be a depth of 7 feet at low water, so that steamers could call and take away fresh and cured fish, and the largest class of fishing boats would be enabled to lie water-borne, at all times of the tide. The estimated cost of this plan is £3300.

The Laggan.

After leaving Bowmore we drove to the Laggan, a beautiful little river, and walked from its mouth up to the bridge on the high road. The river is about the size of the Laxay in the Lews, or the Water of Leith at Edinburgh. In the lower part of its course, it flows for a considerable distance through a wide flat. Its entrance into the sea is free and ample, and there is a deep and spacious sea-pool to the head of which the tide flows. Long ago this used to be the best pool in the river, but of late years fish won't rise in it. Indeed, though the Laggan is full of fish in the season, they are as a rule very shy. They are also small, averaging from 7 to 8 lbs. But they have been caught with the net as heavy as 23 lbs. The Laggan has a beautiful gravelly bottom admirably adapted for spawning in the lower part of its course; and is throughout a fine combination of stream and pool. Between the bridge and the sea there are no stretches of useless, shallow, streamy water. It is all good. There is a pool, called the Kyper Pool, above the sea-pool, and above that again, a long deep pool, with a number of boulders in the bottom of it, termed the Box Pool. It is said to be the best on the river. An eye-witness told me that, about 20 years ago, he had seen 40 salmon, some of them upwards of 20 lbs. weight, taken out of it in a single haul of the net. There are at least 20 nice looking pools in the river, and yet, so far as I could learn, it does not yield above 50 salmon to the rod annually, and perhaps 4 times that number of sea-trout. The factor has killed 5 fish in a day on it; and 40 years ago, takes of 10 and 12 fish a day are said to have been not uncommon under favourable circumstances. The river belongs to Mr Ramsay of Kildalton. It is a very late river; salmon and sea-trout not ascending until the middle of July. August is the best month.

The Sorn.

After leaving the Laggan we drove to the Sorn, a river rather more than half its size, which also falls into Loch-in-daal. The fish in this

river are said to rise more freely than those in the Laggan, and I was told by an old keeper that he had known, some years ago, 8 salmon taken by a single rod and several lost. There is a tweed mill about two miles from the mouth of the Sorn, and there is a waterfall just above the mill which has been blasted with a view of letting the fish up. But the channel made is too narrow and is much encumbered with sharp blocks of stone. It is also too steep and has too much white water in it. There is, however, a narrow natural channel on the right bank of the stream which might be widened and deepened so that fish would be able to pass up; or, a still more effectual plan would be to build a subsidiary dam of concrete across the river just above the bridge. This should be $2\frac{1}{2}$ or 3 feet high. There is a heck on the intake-lade leading to this mill; but none on the tail-lade.

Loch Guirm.

Loch Guirm, as already mentioned, is the largest sheet of fresh water in Islay, and is connected with the sea by a large burn or small river, which falls into Saligo Bay, on the west side of the island, after a course of about a mile and a half. I drove 7 miles, from Bridgend Hotel, to inspect it and the stream flowing out of it. The loch is 4 miles in circumference, and is in general shallow, the deepest part not exceeding 9 feet. It has a sandy bottom, and in stormy weather this sand is stirred up so as to make it almost unfishable. The day I inspected it, the water was like pea-soup, there having been a good deal of wind and rain previously. It contains very fine red-fleshed trout from 2 lbs. downwards. A little above Loch Guirm, and connected with it by a large burn, there is a beautiful little lake, called Loch-a-Chor, which also contains trout of good quality. In old days, both Loch Guirm and the stream that flows from it are said to have contained abundance of salmon. Now, they are salmonless; and I was told the following story by a native of the island concerning the cause of their sterility. Long ago, in the days of St Patrick, both stream and loch abounded in salmon, and a fisherman had promised the Saint the first salmon he caught in the former. But the first fish turned out to be a big one, and the fisherman thought it too good for the Saint, so he determined to keep it for himself, and give the Saint the next one. The second, however, was even bigger than the first, and the fisherman could not make up his mind to part with it; so he thought he would give the Saint the third fish. This proved to be an eel, which he presented to the Saint, who, naturally indignant at the slippery trick played upon him, declared that in all time to come no salmon should be found in the stream. I was not told why St Patrick cursed the unoffending waters instead of the offending fisherman. Possibly he lost his temper, as even holy men have done before and since. But to be promised a salmon and to be put off with an eel was enough to try the patience even of a Saint. I do not know whether the above story appears in the *Acta Sanctorum*. But I give it as it was told by the son of a local gamekeeper who accompanied me as guide to Loch Guirm. I was curious to see the stream where the Saint had been so scurvily treated, and I got my boatman to row me to the foot of the loch, where I landed and followed the course of the stream from the loch to its junction with the sea at Saligo Bay. When I saw it, the loch was quite choked up with a dense growth of weeds a little above the point where the stream issues from it. This thicket of weeds ought to be cleared away. The stream itself is about 12 feet wide, and, as it was about 3 feet below its ordinary autumn and winter level when I saw it, there must be plenty of water at

these seasons to permit the ascent of salmon. There is some good spawning ground in its channel. It ought, however, to be pooled at intervals throughout its course by the erection of small dams across the bed, beginning at a point where a rock extends over nearly the whole breadth of its channel. A little below this rock, there is a perfect forest of tall reeds entirely covering and blocking up the course of the stream, quite impervious to fish, and extending, in one unbroken mass, for several hundred yards. These reeds, I was informed, die down in winter. But if it is wished to give salmon and sea-trout free access to Loch Guirm, which covers nearly 700 acres, the channel of the stream connecting it with the sea should be kept constantly clear and unobstructed, and it would be easy to cut down these reeds with a long handled sickle, and to carry them away. Below this, the stream remains free of weeds, all the way down to the sea, the channel becomes steeper, and it assumes more of the character of a large Highland burn. At its mouth, however, just above high-water mark, it is much choked up by large stones which might easily be removed. A little further up, the channel is crossed by a bridge formed of a single large stone. A dam about a couple of feet high should be formed just below this bridge, as above it there is a broad shallow part of the stream which ought to be deepened in order to facilitate the ascent of salmon. A little above Loch Guirm, and connected with it by a considerable stream, there is a smaller loch called Loch-a-Chor. If it were wished to open up these two fine lochs to salmon, the stream between Loch Guirm and the sea should be cleared of weeds and pools formed in it as resting-places for the ascending fish; and the stones in its channel just above high-water mark should be removed. If these improvements were carried out, I have no doubt that the Saint would relent, the curse would be removed, and that salmon would get up. It might also be advisable to make some hauls of the net in Saligo Bay, into which the stream from Loch Guirm falls, and to take some pairs of salmon ready to spawn, and place them on the gravel in the stream below Loch Guirm, and in that between Loch-a-Chor and Loch Guirm, as the smolts bred in these upper waters would naturally, after their descent to the sea, attempt to return to their birthplace as grilse and as salmon.

I have the honour to be,

Your obedient servant,

ARCHD. YOUNG,

Inspector of Salmon Fisheries for Scotland.

THE FISHERY BOARD FOR SCOTLAND,
EDINBURGH, *March* 15, 1886.

NOTE I.—APPENDIX G.

LOCAL MOVEMENTS OF THE SALMONIDÆ. A Paper read at the Half-Yearly Meeting of the Scotch Fisheries Improvement Association, Edinburgh, 30th November 1885, by W. ANDERSON SMITH, Ledaig, Argyllshire.

THE general movements of the Salmonidæ, in sea-water more especially, are so little known that it may help the subject if I endeavour to bring together a few facts concerning those frequenting the waters of this part of Lorn. Even should the facts in themselves not be absolutely new they may corroborate, or suggest new departures for, the facts gathered by, or the observations still to be made by, other inquirers.

The great water-way of the Linnhe Loch furnishes an admirable ground for the student of this particular class of fishes. For the lochs that form sub-waters are so extensive and so wide apart, that the various fishes have ample range and sufficiently diverse conditions to differentiate to a remarkable extent, quite enough to be readily distinguished one from the other by unscientific but otherwise skilled and practical observers. If, in the case of the herring,—as is assumed on presumptive evidence,—the varieties are mainly produced by variety of feeding provided by each loch or range of feeding ground, this can scarcely be the case with salmon, as this fish cannot be said to feed to any practical extent in fresh water except in its early stages as parr and smolt, when it is just possible the peculiar characteristics *may* be given, however difficult it would be to distinguish them at that stage.

At any rate the salmon of the various rivers from the Lochy to the Nant gradually find their way into Loch Linnhe, and thence apparently proceed in a great body out to sea beyond Mull. What they do there it would be difficult to assert positively, as facts are greatly wanted in this connection—but the probability is that they go to fatten upon the herring, as most other fishes do that are greatly voracious. That the salmon must be of such a character, is abundantly evident from its rapidity of growth when once it gets to salt water.

These fish go, not in one, but in various shoals through the season, and commence returning early, striking Mull near Lochbuy, and thence advancing by Kerrera towards Loch Linnhe. The consequence of this is, that the man who some years ago commenced a fishery on the island of Kerrera, levied virtual blackmail on the shoals that passed on to all the higher rivers, and made a marked difference on the fishings of such rivers as the Awe.

As the shoals passed up Loch Linnhe the fish of the Loch Etive streams first left the main body, and then those of Loch Creran, Loch Leven, &c. Those of Loch Etive had thereafter to divide as they reached the Nant, the Awe, and the numerous other salmon streams that enter that noble loch. Now a remarkable but recognised thing is, that while the mouths of the Nant and of the Awe are close alongside, the fish of either will not enter the other *beyond a certain point*. Thus, those of the Nant may enter the mouth of the Awe should the water of the former river be too low to permit their ingress at all—but they will not proceed beyond the mouth. Again, the Awe fish have been caught at the head of Loch Creran but not *in* the Creran river. They may blunder so far as to miss the mouth of Etive, but they apparently soon discover their error, and return again upon their course. The difficulty of finding the entrance to Etive or Creran is not little, and it cannot be

wondered at that a few fish occasionally fail to leave the main body along with their comrades. But it *is* to be wondered at that, finding out their error, they should start off again to repair it.

When the fish come in towards the shore, they may be taken in the nets at Dunstaffnage Bày before entering the Etive Loch, and again in Aird's Bay before entering Loch Creran, but once they have entered these lochs their course seems to be straight up towards the head in the case of Creran, or towards the Awe and Nant in the case of Etive. We are not aware of any case (except one) in which salmon have been taken in these lochs in shallowish water or near the shore. Those who "scringe" or seine for sea-trout do not find the salmon amongst their prey, nor do we believe that the salmon delays in ordinary cases between the mouth of the loch and the mouth of its own river. A friend informs us that only twice in twenty years has he seen a salmon leaping in play in lower Loch Creran, and we have frequently observed the swift course of a salmon near the surface of the water in mid-loch, going straight towards the head of the loch without halting.

The sea-trout on the other hand, keep close inshore, comparatively speaking, and lay themselves open to the operations of the scringers. At regular intervals, more especially at spring tides in June and July, the sea-trout pass slowly upwards along the shore to their various rivers, continuing to do so on till October. By the middle of November they have mostly left the fresh waters.

These shoals of sea-trout open up questions of great interest most difficult to answer. "Sea-trout" they are all roughly called in the West of Scotland, but they undoubtedly represent several species, and perhaps many varieties. Not only have the fish of each several stream a character of their own, but they are found intermingled with the *Salmo fario* from the smaller streams, that have taken to the sea, and in consequence donned a livery of silver more or less pronounced. These include the common *Salmo fario*, as well as the species *estuarius*, which may be considered as intermediate. We have little doubt that the *Salmo fario* takes to the sea at certain seasons, when we cannot find a single representative in the small streams that enter the Western Highland lochs. We have found them amidst the sea-weed at low water, where the stream struggles over the salt-watery shore; while we could not find a single point of specific distinction between the silvered specimens amongst the shoals of sea-trout and their dark-coloured congeners in the burns. It has long been well known and thoroughly proved that the external colouring and superficial characteristics of fishes alter readily under changed conditions; and the marked differentiation evident amongst the various fishes of the different streams, as well as between the same fishes in the said streams or off them in the salt water, point to great facility of alteration and mobility of physical characteristics.

We have also taken in certain streams fishes that we would have called sea-trout but for their complete absence of silver colouring, the marking pointing to them as bull-trout.

These we are disposed to consider sea-trout that have remained long in fresh water and lost their silver coat, as the *Salmo fario* acquires it in the salt water.

These sea-trout shoals are most voracious; we have taken young herring in quantities, and squids also, from their stomachs, and this may be the reason they keep towards the shore in their progress river-ward, in place of rushing thither in mid-loch.

The salmon, on the other hand, when it approaches the shore is not bent on feeding, although we have heard of them being taken by boys with lines baited with sand-eels for flounders. They are like our best herring, which are no longer on the feed when they approach the shore for spawning

purposes. It is extremely difficult to obtain facts regarding sea-salmon proper, or to distinguish them from the fish of the rivers in the vicinity of the coast where they are captured. Mull and the other islands have rivers and plenty of fish of their own, or else we might seek to ascertain what food they are supplied with when they first make the south shores of Mull on their way to Loch Linnhe. These fish are sent to the South untouched, and therefore the question remains unanswered so far as we are concerned. But we wish to direct special attention to the point, believing as we do that the salmon goes to sea in pursuit of the herring, whose oily nature supplies the rich body of the salmon with its heavy juices, until the fish becomes so gorged and plethoric with its wealth of feeding that it becomes a prey to the parasite that is ever ready provided to prey upon any rich constitution. This parasite, and its instincts of reproduction, drive the body of fish from the rich feeding grounds of the outer waters in towards the rivers, in which, although they may swallow some trifling articles of food, they may yet be said to live upon their plentiful fat until—reduced to famished and voracious skeletons—they once more, as kelts, seek the outer waters, and the abundant herring harvest that awaits their onslaught.

The fact that a fish will return in six weeks to its native river many pounds in weight additional, points to a rich and plentiful supply of nourishment, that only this "rabbit of the sea," as it has been termed—the herring—prolific and nutritious, could possibly supply to such vast shoals of large and voracious fish.

Had the salmon hunted in isolated bodies like the small shoals of sea-trout, that do not apparently go so very far out to sea, and are more readily supplied with an omnivorous diet, it might have been possible to understand their living on a mixed and widespread table. But their coming together in such important bodies, increasing as they pass seaward, points to an important food supply, that only the herring shoals, never absent from these outer waters, can well be supposed to constitute.

The study of the food of most animals goes a long way to elucidate the principles that actuate their movements, and we wish to direct attention to the apparent fact that the salmon returns to the rivers and streams with such a store of vitality that it virtually carries them through the period of gestation and spawning, and consequently what it may or may not eat in these waters is a matter of trifling economic import. What we wish to discover is whether facts have been or are forthcoming to settle if this noble fish preys, like the bulk of our food fishes, upon the herring, as thereby we would arrive at another definite principle whereby its movements could be somewhat calculated.

For the division of salmon in most rivers into spring, summer, and autumn migrations may be necessitated by the difficulty of procuring nourishment for the whole salmon population of a river in one great body, and through our modes of fishing out certain migrations we may really be lessening the power of a river, not by lessening its fish capacity, but by too great concentration of the fish shoals, that ought naturally to be spread over the year. We have looked upon the sea as inexhaustible, nor troubled ourselves about how or where the sea-salmon can derive nourishment, but the salmon will doubtless have arranged this to its own satisfaction long ere we set about altering the conditions of the problem by unwise and inconsiderate fishing.

In this connection it may be well to add that the sea-trout, while freely devouring herring-sile, does not apparently return so plethoric, nor so capable or willing to starve in fresh water. It is one of the most formidable enemies of the salmon, eating it in quantities in the early stages; and while the youngsters can escape the voracity of the kelts by seeking shallow waters, the sea-trout is only too well fitted to follow them thither. The undue protection

and cultivation of the sea-trout is a matter to which careful attention should be given. It can people streams to which the salmon cannot aspire, but it levies heavy tribute from the nobler fish, and it may be well to ask ourselves whether the cultivation of the sea-trout conterminously with the salmon in some waters is not an attempt "to eat our cake and have it." In the smaller rivers and streams the sea-trout is probably the more valuable economic inhabitant of the two, but in larger rivers it may be found that its presence is purchased at too great a price. At any rate we are satisfied from our own observation that the habits of the two fishes are markedly different, and that in the case of the salmon the estuary of a river in such a water system as Loch Linnhe may really and truly extend beyond the island of Mull.

NOTE II., APPENDIX G.

BENEFICIAL RESULTS OF ARTIFICIAL SALMON CULTURE ON THE SALMON FISHERIES IN THE MARITIME PROVINCES OF CANADA, from the Report of Mr Wilmot, Superintendent of Fish Culture for Canada. Ottawa. 1885.

"The annual Reports, and the statistics alluded to, will show:—

(1.) That in the fishery divisions of the counties of Gaspé, Bonaventure, Restigouche, and Gloucester, in the Provinces of Quebec and New Brunswick, which border upon the Bay des Chaleurs, where the benefits from the Gaspé and Restigouche salmon hatcheries have been regularly applied since their commencement in 1874 and 1875, the official returns from 1881 to 1883 inclusive, show an increase in the catch of salmon in those counties collectively as follows:—

$40\frac{1}{2}$ per cent. increase in 1883 over 1881.
$34\frac{1}{2}$ per cent. increase in 1883 over 1882.

(2.) That in the Gaspé sub-division, in the Province of Quebec, which takes in the several rivers which have been stocked with salmon fry from the Gaspé Hatchery the official returns from 1881 to 1883 inclusive, show a continuous increase in the catch of salmon there as follows:—

211 per cent. increase in 1883 over 1881.
84 per cent. increase in 1883 over 1882.
$68\frac{3}{4}$ per cent. increase in 1882 over 1881.

(3.) That in the Restigouche sub-divisions, partly in Quebec and New Brunswick, which take in the tidal portions of the Restigouche River and a part of the estuary fishing; where the proceeds of the Restigouche salmon hatchery have been regularly applied; a steady increase in the salmon catch is shown by the returns as follows:—

41 per cent. increase in 1883 over 1881.
45 per cent. increase in 1883 over 1882.

(4.) That in the North Shore divisions in the Province of Quebec, namely, Godbout, Trinity, Moisie, Mingan, Natashquan, Washeecootai, St Augustin, and Bonne Espérance, *where no benefits from artificial salmon breeding could be applied* (except on the Saguenay River), the returns from 1881 to 1883 inclusive show the catch of salmon to be as follows:—

$3\frac{1}{2}$ per cent. decrease in 1882 under 1881.
24 per cent. *decrease* in 1883 under 1882.

(5.) That while the above-named North Shore divisions collectively show a falling off in the catch of salmon; yet that portion of the Saguenay division, which takes in the salmon fisheries of the Saguenay River; where the proceeds

of the Tadoussac Hatchery have been given to its branches; the same returns, within the same years, show an increase as follows:—

66 per cent. increase in 1882 over 1881.

115 per cent. increase in 1883 over 1881.

(6.) That in the Northumberland fishery district in the Province of New Brunswick, which takes in the estuary and river fisheries of the Miramichi River, upon which a salmon-breeding establishment has been in operation since 1875, the returns show an increase from 1881 to 1883 inclusive, in the catch of salmon thus:—

95 per cent. increase in 1882 over 1881.

15 per cent. increase in 1883 over 1881.

(7.) That in the following counties in the Province of Nova Scotia, namely, Annapolis, Cumberland, Colchester, Guysboro, Halifax, Hants, Kings, Lunenburgh, Pictou, and Queens, in the rivers of which young salmon fry from the Bedford Hatchery have been distributed since 1876, the official returns show a large increase in the salmon fisheries from 1881 to 1883 inclusive as follows:—

150 per cent. increase in 1882 over 1881.

120 per cent. increase in 1883 over 1881.

(8.) That in the following counties in the Province of Nova Scotia, namely, Antigonish, Cape Breton, Digby, Inverness, Richmond, Shelburne, Victoria, and Yarmouth, where salmon fry have not been planted from the hatcheries, the returns show a very small increase in the salmon catch from 1881 to 1883, when compared with the counties where artificially-bred fry have been planted, as follows:—

45 per cent. increase in 1882 over 1881.

40 per cent. increase in 1883 over 1881.

Thus it will be seen that in every instance where the localities have received supplies of artificially bred fry, a large increase in the catch of salmon is shown over those that have not received supplies of young salmon from the hatcheries.

Now, whilst these official returns for 1881–82, and 1883 give undoubted evidence of an increased catch of salmon in all of the districts in the several Provinces where artificially bred fry *have been planted* since the commencement of their propagation in a small way in 1875–76, and 1877; they also show a decided decrease in the catch of these fish, at the same time, in the several districts where young salmon *have not been planted.* It is nevertheless a deplorable fact that all the salmon fisheries in the Atlantic Provinces have fallen off to an alarming extent from the general returns of former years.

It is not intended to be put forth here that this improvement of the salmon fisheries in the several districts where only moderate supplies of young salmon have been deposited in the rivers from the hatcheries has been brought about wholly from artificial breeding; and it must not be gainsaid either, that these fish-breeding institutions are not entitled to a fair share of the credit for the results shown by these returns; for it could not so happen by any law or freak of nature of an accidental or co-incidental character that such a preponderating difference could take place between the various waters that were artificially stocked and those that were supplied by the natural process alone. Therefore it is but reasonable to conclude that the improvement in the fishery divisions described must have been the result of the influences of the natural and artificial methods of propagation combined, and this is all that has ever been advocated by the practical, intelligent, and honest supporter of the science of artificial fish culture, as being a most useful adjunct, and an important subsidiary aid to the natural method which has been and is now so seriously interfered with by such a multitudinous number of destructive agencies as almost to forbid the possibility or power of man to control.

I cannot find words more apposite to describe the ruin going on in the fisheries, or to give the cause and the remedy for the evil than in a former Report of the Inspector of Fisheries for New Brunswick. I therefore quote briefly from it, where speaking of the alarming decrease in the stock of all anadromous fishes that frequent the waters of that Province, he says:—'They 'show beyond a doubt that this decrease has been brought about by wasteful 'and extravagant modes of fishing in some places, and by overfishing and 'insufficient protection everywhere. They show that these causes are still 'actually at work—that fishing operations are annually extending, while 'protection is annually becoming less; that all the causes which follow in the 'train of rapidly-increasing population are in full and increasing activity. 'They show that everywhere, except where artificial culture has arrested the 'decrease, the salmon fishing is in the same danger.'"

NOTE III., APPENDIX G.

THE BIENNIAL SPAWNING OF SALMON. (The Bucksport Experiments.) By Charles G. Atkins, from the Transactions of the American Fisheries Society, 1885.

After the organization of the establishment for the collection of eggs of sea-going salmon at Bucksport, on the Penobscot river, in 1872, it was one of the earliest suggestions of Professor Baird that we should attempt, as occasion might offer, to obtain evidence bearing on the frequency and duration of the salmon's migrations and its rate of growth.

To carry out these suggestions it seemed requisite that observations should be made on individual fishes at successive periods in their lives; yet, whatever means should be taken to secure and identify them must, it was evident, not prevent free movement in the open river to and from the sea, or interfere in any way with the development of their functions or their regular growth. They must be distinctly and durably marked, yet in such a way as to do them no injury. The cutting of the fins would answer the purpose only in part, since it would not afford a sufficient variety in form to enable us to distinguish a great number of individuals. Branding upon the side of the fish was thought of and even tried, but the serious mutilation that befel the first fish operated on, and the extreme probability that those marks that were so lightly impressed as to do no injury to the fish would soon become illegible, or so nearly so as to be overlooked by fishermen, caused that method to be abandoned. A metallic tag, stamped with a recorded number, appeared to offer the greatest promise of success. The first tag tried was of thin aluminum plate, cut about half an inch long and a quarter wide, and attached to a rubber band which encircled the tail of the fish, It is possible that most of the bands slipped off, and that those which were tight enough to stay on cut through the skin and produced wounds that destroyed the fish. At any rate, no salmon thus marked were ever recovered.

The next method employed was the attachment of an aluminum tag by means of a platinum wire to the rear margin of the first dorsal fin. This place of attachment was chosen because, being near the middle of the fish, it has less lateral motion when the fish is swimming than any point nearer the head or tail, and because the tag, lying thus in the wake of the fin and close to the back, would be better protected from contact with foreign objects than elsewhere. The attachment was effected by placing the fish upon a narrow

table, confining it by straps, and piercing the thin membrane of the fin between the last and next to the last ray, by means of a needle, into the eye of which was threaded the wire already connected with the tag; the ends of the wire were then twisted together, so as to form a loop, and neatly trimmed with scissors. The tags were stamped with dies. This mode of marking has been adhered to in all subsequent experiments of the kind, with no change except that the aluminum tag has been replaced by one of platinum.

The marking was always done in the fall, after the fish had been relieved of their spawn. They were then liberated, either in tide water or in fresh water, whence egress to the sea was easy.

Of the salmon marked with rubber bands in 1872, as has been said, none were recovered. In November 1873, there were marked 391 salmon. In the ensuing year rewards were offered to the fishermen for the return of any marked specimens. In response, there were sent in to the station twenty salmon, the first in January (taken in a smelt net), and all the others in April and May. All of the twenty retained the wire, by which they were with certainty recognised as having been marked in the preceding autumn. Sixteen of them still retained the tags. One of them was found to have lost eight ounces in weight, eight others had lost from one to two pounds each; all had fallen away in flesh since November. The males had faded in colour; the hooks on their lower jaws were still present, but had decreased much in size. The females had regained their bright silvery colour to a great extent; in their ovaries were the germs of the next litter of eggs, but they were very small. No food could be found in the stomachs of either sex. It was quite evident from their condition that these fishes could not have been to their feeding grounds during the winter. Twelve out of the twenty were taken in the Penobscot above Bucksport, and nine of these were taken at Veazie, twenty-five miles above Bucksport, in close proximity to the first serious obstacle they would encounter in ascending the river. Salmon in their condition should be bound towards the sea, and had they, as may have been the case with some, reached the upper waters, it is quite impossible that they could have become breeders the same year. That all these loiterers dropped down to the sea before the 1st of June, we may conclude from the fact that after that date no more were captured. During the whole year not a single marked fish was recovered or reported, that had in any degree mended from the condition in which it was released the preceding autumn.

In 1875 the offer of a reward was renewed, and this time resulted in the recovery, in May and June, of eight specimens, and among our breeding fish there was found in the autumn another whose mark had escaped observation at the time of capture. Of the nine fish, four were females, three males, and two not determined. They were all of good size, weighing from 16 to $24\frac{1}{4}$ pounds, and measuring $34\frac{1}{2}$ to $40\frac{1}{2}$ inches in length, and were all fat and apparently healthy. One of the females was placed alive in our inclosure and yielded in the fall about 11,500 eggs. Unfortunately, the tags, supposed to have been good aluminum plate, proved deficient in durable properties, became (as we learned by direct observation) weak and brittle after a short time in water. All of them had fallen off from these specimens, and we could not therefore trace the record of the individual salmon, but the wire remained and proved beyond question that these salmon were marked and released in November 1873, as none others had up to this time been marked in the same manner, and none at all marked in 1874. They had thus been absent eighteen or nineteen months, and had (we cannot doubt) passed the intervening months, including the summer of 1874, mainly on their feeding grounds in the sea. The experiment was repeated in 1875 and 1880, with platinum tags, which proved durable.

In 1875 there were marked and released in tide water, at Bucksport,

357 salmon. In the spring of 1876 a considerable number of these were taken in the river; but without exception they were, as in 1874, all poor. In 1877 three specimens were recovered, all in good condition and of larger size than when released. The first, No. 1019, was caught on Cape Gellison in April. This was a female fish; before spawning it weighed 21 pounds 6 ounces, and at time of release 16 pounds. When retaken, seventeen months later, it weighed $33\frac{1}{2}$ pounds. The second individual, No. 1010, was also a female; weighed before spawning 18 pounds 2 ounces, after spawning 13 pounds 8 ounces, and on recapture in Lincolnville, nineteen months later, 30 pounds 8 ounces. The third individual was also a female; weighed 20 pounds 7 ounces before spawning, 15 pounds on release, and 26 pounds on recapture in Lincolnville, nineteen months later. The results of this second experiment supported the conclusions drawn from those of the first in every particular.

The salmon marked in 1880, numbering 252, were released in the fresh waters of Eastern river, a small branch of the Penobscot. The distance from the point of liberation to tide-water was two miles, and the only impediment a dam, over which they could easily go down in the spring, or at any high water when the river was not very low, but which during the winter must have constituted a serious impediment. There is reason for thinking that the larger part of these salmon remained above the dam until the spring floods. A small reward was offered for the return of fish or tags taken the next spring, and twelve tags were received. Nine of the fish bearing them were weighed and found in every instance to have fallen away in weight since marking. No fully or partially mended fish were obtained or heard of that year. But in June 1882, five prime salmon were recovered bearing the tags affixed in October and November 1880. The following statement shows the date for each individual:—

RECORD OF MARKING.

No.	Date.	Sex.	Length.	Weight before spawning.		Weight of eggs.		Weight on release.	
	1880.		inches.	lbs.	oz.	lbs.	oz.	lbs.	oz.
1135	October 28.	F.	30	9	7	1	15	7	8
1136	October 28.	F.	30	9	5	2	1	7	4
1239	November 5.	F.	36	17	12	3	8	14	8
1248	November 5.	F.	32	10	5	2	5	8	0
1247	November 12.	M.	$30\frac{1}{2}$	...	...	...	...	8	8

RECORD OF RECAPTURE.

No.	Date.	Place.	Length.	Weight.	
	1882.		inches.	lbs.	oz.
1135	June 20.	Bucksport Center.	$34\frac{1}{2}$	16	8
1136	June —	Searsport.	$35\frac{1}{2}$	17	4
1239	June 22.	Sandy Point.	$39\frac{1}{4}$	21	0
1248	June 27.	North Bucksport.	39	21	0
1274	June 23.	Frankfort.	...	14	12

The results of this third experiment coincide, it will be seen, with those of the other two, and they leave little room for doubt that it is the normal

habit of the Penobscot salmon to spawn every second year. Had any considerable number of them recovered condition in season to return to the river for spawning the year after their first capture, they would hardly have escaped detection altogether; indeed, they would have been much more likely to retain their tags, since they would have borne them only six or seven months, instead of eighteen or nineteen. This view is further supported by what we know of the reduced condition in which the end of the spawning season finds the salmon, the short time, only six months, that intervenes between the spawning season and the time for the next 'run' up the river, the low temperature then prevailing in the river and bay, and the fact, which is pretty well established, that a large part, perhaps nearly all the salmon, instead of proceeding at once to sea after spawning, linger in the fresh water all the winter, and descend only with the spring floods.

NOTE IV., APPENDIX G.

The following Memorandum on the Loch Torridon rivers, supplementary to that published by me in my Third Annual Report to the Board (pages 136 to 140) was sent me by Mr Darroch of Torridon in August last. It is now printed as completing his evidence with regard to these rivers.

SUPPLEMENTARY MEMORANDUM ON LOCH TORRIDON RIVERS, ROSS-SHIRE.

In my Memorandum printed by you on page 136 of your report for 1884, I endeavoured to prove that the fixed nets inside Loch Torridon were the cause of our river fishing being ruined, and I expressed an opinion that the stock of salmon was nearly exhausted by them. On the 11th August 1885 my keeper went with a stranger to show him the Balgy, and was agreeably surprised to see salmon again jumping at the falls.

On the 15th I went myself to inspect, and found that salmon were jumping away as we had not seen them do for many years. I saw two large ones get right up the fall.

At first sight, it seemed as if I had been mistaken as to the fact of the nets intercepting our fish, but from information received I yesterday went down to Craig, the place where our enemies the bag nets begin.

I found there all the nets ashore, and ascertained from the man in charge that as they were not getting enough fish to pay, they had, acting on instructions from headquarters, taken up all the nets on 3rd August, and that the season had been a failure.

This seems to prove:—First, that the capital stock of fish has been, as I asserted, so reduced by the perpetual netting inside the natural estuary as to be practically extinct for commercial purposes; second, that directly the intercepting nets are removed, the few fish that remain at once rush up to their native spawning ground in our rivers.

(Signed) DUNCAN DARROCH.

Torridon, 21*st August* 1885.

APPENDIX G. No. II.

Bye-laws hitherto unpublished except in Edinburgh Gazette.

BYE-LAWS APPLICABLE TO THE RIVER HOWMORE IN THE ISLAND OF SOUTH UIST :—

Name of River.	*Limits of District and Division between Upper and Lower Proprietors.*	*Date from which Bye-law took effect.*
HOWMORE . . .	1st. That the limits of the District of the Howmore River shall be the whole coasts of the Islands of South Uist, Benbecula, and Barra, and the whole coast of the adjacent islands and islets presently possessed by John Gordon, Esq., of Cluny ; and that the district shall consist of the portions of the sea coast and the estuary and the river of the said islands. 2nd. That the point below which the proprietors of fisheries shall be lower proprietors, and above which the proprietors of fisheries shall be upper proprietors, shall be a line drawn across the river 100 yards below the new road leading from the North Ford to the Sound of Barra.	12th Dec. 1871.

Name of River.	*Limits of Estuary.*	*Date from which Bye-law took effect.*
HOWMORE . . .	A portion of a circle of 500 yards radius, to be drawn from a centre placed mid-channel in the river where it joins the sea at low water of equinoctial spring-tides, and continued shorewards by tangents to the circle drawn to the nearest points of the shore of the respective sides of the river at high-water mark ; also of equinoctial spring-tides.	8th March 1872.

Name of River.	*Annual Close Time.*	*Extension of Time for Rod Fishing.*	*Date from which Bye-law took effect.*
HOWMORE . . .	From 10th Sept. to 24th Feb., both days inclusive.	From 10th Sept. to 31st Oct., both days inclusive.	8th March 1872.

ORKNEY AND SHETLAND ISLANDS.

The Orkney and Shetland Islands have been erected into Fishery Districts within the scope of the Salmon Fishery Acts of 1862 and 1868, since these Acts and relative Bye-laws were published, but the Bye-laws constituting them have as yet been published only in the *Edinburgh Gazette*. They are now given below.

ORKNEY ISLANDS.

Name of River.	Limits of District and Division between Upper and Lower Proprietors.	Date from which Bye-law took effect
River from Loch of Stenness, &c.	1st. That the limits of the River flowing out of the Loch of Stenness under the Bridge of Waithe into Ireland Bay; of the Kirbuster Water (Loch of Orphir); of the Græmeshall Water (Loch of Græmeshall); of the River flowing out of the Loch of Boardhouse; and of the River running out of the Loch of Swannay; shall be the whole coasts of the Island of Pomona or mainland of Orkney, of the Island of Hoy, the Island of Shapinshay, the Island of Rousay, the Island of Westray, and the adjacent Islands and Islets forming part of the Orkney group, and that the District shall consist of and include the whole Sea Coasts, Rivers, and Estuaries of the said islands. 2nd. That the point below which the Proprietors of Fisheries shall be Lower Proprietors, and above which the Proprietors of Fisheries shall be Upper Proprietors, shall be, with regard to the River flowing out of Loch Stenness, the Bridge of Waithe; with regard to the Water flowing out of the Loch of Orphir, the Bridge over the said Water near the Mill on the Road leading from Kirkwall to Orphir; with regard to the Water from Græmeshall Loch, the Bridge over the said Water; with regard to the Stream running out of the Loch of Boardhouse, the Bridge, commonly called the 'Palace Bridge,' over the said Stream; and with regard to the Water from the Loch of Swannay, the Bridge on the High Road between the Loch and the Sea. That, with regard to the Islands in which no Rivers have been designated, the Proprietors of the whole Coasts thereof shall be Lower Proprietors.	16th Dec. 1881.

Name of River.	Limits of Estuary.	Date from which Bye-law took effect.
River from Loch of Stenness, &c.	A straight line drawn from Houton Head to the Ness on the west side of Stromness Harbcur; as regards the Kirbuster Water and Græmeshall Burn, a straight line drawn from Houton Head to Roseness; as regards the Water from Tankerness Loch, a straight line drawn from Moul Head to Rerwick, and from Rerwick to the Head of Work; as regards the Water from Wasdale Loch, a straight line drawn from the Ness to the north of the Bay of Isbister to Carness; as regards the Burn flowing into the Bay of Woodwick, a straight line drawn from Scarataing on the north to Midgarth on the south; as regards the Burn at Aikerness, a straight line drawn west-north-west from Aikerness Point till it meets the mainland; as	1st Sept. 1882.

Name of River.	*Limits of Estuary.*	*Date from which Bye-law took effect.*
River from Loch of Stenness, &c.	regards the River flowing from the Loch of Boardhouse, a straight line drawn from the outermost point of the Brough of Birsay to Marwick Head; as regards the Lyrwall and Mill Bay Burns (Island of Hoy), a straight line drawn from Heckness to Green Head; as regards the Burn falling into Hoy Sound near Linkness, a straight line from Bow to Bring; as regards Rackwick Burn, a straight line from Roray Head to Snuick Head; as regards Sauren Water (Island of Rousay), a straight line from the south-east point of the Peninsula of Stockness to a point on the coast of Rousay where the Egilshay Peat Road runs down to the sea; as regards the Saviskail Burn, a straight line from the South Gio of Saviskail Head to a point on the coast of Rousay where the Saviskail Road runs down to the Sea; as regards the Streams running into Pierowall Bay (Island of Westray), a straight line drawn from Breckaskail to Cleat; as regards Elwick Burn (Island of Shapinshay), a straight line from Balfour Castle to Hacosness; and as regards Strathore Burn, a straight line from Galtness to Gioness.	1st Sept. 1882.

Name of River.	*Annual Close Time.*	*Extension of Time for Rod Fishing.*	*Date from which Bye-law took effect.*
River from Loch of Stenness, &c.	From 10th Sept. to 24th Feb., both days inclusive.	From 10th Sept. to 31st Oct., both days inclusive.	1st Sept. 1882.

SHETLAND ISLANDS.

Name of River.	*Limits of District and Division between Upper and Lower Proprietors.*	*Date from which Bye-law took effect.*
River of Sandwater, &c. . . .	1st. That the limits of the District embracing the River of Sandwater running into the Loch of Strome, and thence into Stromness Voe; the stream running into Bixter Voe; the Laxo running into Dourie Voe; the Stream running into the sea near Scalloway out of the Tingwall Lochs; the Stream running into Dales Voe (Parish of Tingwall); the Stream running into the head of Laxfirth Voe; the Wees running into the Head of Weesdale Voe; the Stream running through Laxobigging into Garth's Voe; the Stream running into Grutting Voe above the Bridge of Walls; the Streams running into Vulem Voe; the Stream running into Busta Voe; the Streams running into Urie Firth; the Streams running into Colfirth Voe; the	16th March 1883.

Name of River.	*Limits of District and Division between Upper and Lower Proprietors.*	*Date from which Bye-law took effect.*
River of Sandwater, &c.	Streams running into Unyfirth; the Streams running into the sea at West Burrafirth; the Streams running into Aiths Voe: the Streams running into Foutabrough Voe; the Streams running into Vaila Sound; the Stream from the Loch of Gossawater running into Skelda Voe; the River of Vadsgarth running into the sea at the Sands of Mail; the Burn of Voxter running into Aiths Voe; the Burn of Hoswick; the Burns of Channerwick and Claver running into Channerwick; the Burn of Clumlie running into Troswick; the Stream running into Quendale Bay; the Stream running out of the Loch of Brow into the Loch of Spiggie, and from thence flowing into the sea; the Stream running into the sea out of the Loch of Vatsetter; the Stream running into Tresta Voe (Island of Fetlar); the Stream running into Cullivoe, and the Stream running out of the Loch of Gutcher (Island of Yell); the Stream running into Basta Voe (Island of Yell); the Arisdale Burn running into Hamna Voe (Island of Yell); the Streams running into Whalfirth Voe (Island of Yell); the Stream running out of Watley Loch (Island of Unst) into the Loch of Cliff, and from thence flowing into the head of Burrafiord; the Streams running into Balta Sound (Island of Unst); the Stream into Snarravoe (Island of Unst); the Streams running into the Bay of Belmont; and of the Streams running into Uya Sound (Island of Unst),—shall be the whole Coasts of the Island known as the Mainland of Shetland, of the Island of Yell, of the Island of Unst, of the Island of Fetlar, of the Island of Bressay, of the Island of Whalsay, of the Island of Muckle Roe, of the Island of Papa Stour, and of the other Islands and Islets belonging to the group known as the Shetland Islands, and that the District shall, besides and in addition, consist of and include the whole Sea Coasts, Estuaries, Voes, Bays, Sounds, Rivers, Streams, Lochs, and Waters of the said Shetland Islands not specially enumerated herein. 2nd. That the point below which the Proprietors of Fisheries shall be Lower Proprietors, and above which the Proprietors of Fisheries shall be Upper Proprietors, shall be—as regards the River of Sandwater running into the Loch of Strome and thence into the head of Stromness Voe, the bridge across it on the high road from Lerwick to Walls; as regards the Stream running into Bixter Voe, the bridge across it on the high road from Weesdale Voe to the Bridge of Walls; as regards the Laxo running into Dourie Voe, the bridge across it on the high road from Olnafirth to	16th March 1883.

Name of River.	*Limits of District and Division between Upper and Lower Proprietors.*	*Date from which Bye-law took effect.*
River of Sandwater, &c.	Flugarth; as regards the Stream running out of the Lochs of Tingwall into the sea near Scalloway, the bridge across it on the high road from Scalloway to Lerwick; as regards the Stream running into Dales Voe (Parish of Tingwall), the bridge across it on the old road from Lerwick to Tingwall; as regards the Stream running into Laxfirth Voe, the bridge across it on the high road near Strand; as regards the Wees running into Weesdale Voe, the bridge across it on the high road from Lerwick to Walls; as regards the Stream running through Laxobigging into Garth's Voe, high-water mark of spring-tides; as regards the Stream running into Grutting Voe, the Bridge of Walls; as regards the Streams running into Sulem Voe, high-water mark of spring-tides; as regards the Stream running into Busta Voe, the bridge across it on the high road; as regards the Streams running into Urie Firth, the Streams running into Colfirth Voe, the Streams running into Unyfirth, the Streams running into the sea at West Burrafirth, the Streams running into Aiths Voe, the Streams running into Foutabrough Voe, the Streams running into Vaila Sound, and the Stream running out of the Loch of Gossawater into Skelda Voe, high-water mark of spring-tides; as regards the River Vadsgarth running into the sea at the Sands of Mail, the Burn of Voxter running into Aiths Voe, the Burn of Hoswick, the Burns of Channerwick and Claver, the Burn of Clumlie running into Troswick, the Stream running into Quendale Bay, the Stream running out of the Loch of Brow into the Loch of Spiggie, and from thence flowing into the sea, and the Stream running into the sea out of the Loch of Vatsetter, high-water mark at spring-tides; as regards the Stream running into Tresta Voe (Island of Fetlar), the bridge across the said Stream; as regards the Stream into Cullivoe, and the Stream running out of the Loch of Gutcher (Island of Yell), high-water mark of spring-tides; as regards the Stream running into Basta Voe (Island of Yell), the bridge across it on the high road; as regards the Arisdale Burn running into Hamna Voe (Island of Yell), the bridge across it on the high road; as regards the Streams running into Whalfirth Voe (Island of Yell), high-water mark of spring-tides; as regards the Stream running out of Watley Loch (Island of Unst) into the Loch of Cliff, and from thence flowing into the head of Burrafiord, a straight line drawn across the said Stream where it issues from the Loch of Cliff; as regards the Streams running into Balta Sound, the Stream running into Snarravoe,	16th March 1883.

Name of River.	*Limits of District and Division between Upper and Lower Proprietors.*	*Date from which Bye-law took effect.*
RIVER of SANDWATER, &c. . . .	the Streams running into the Bay of Belmont, and the Streams running into Uya Sound (all in the Island of Unst), high-water mark of spring-tides ; and as regards the other Rivers, Streams, Burns, and Waters within the Fishery District of the Shetland Islands not specially designated herein, that the point below which the Proprietors of Fisheries shall be Lower Proprietors, and above which the Proprietors of Fisheries shall be Upper Proprietors, shall be high-water mark of spring-tides.	16th March 1883.

Name of River.	*Limits of Estuary.*	*Date from which Bye-law took effect.*
RIVER of SANDWATER, &c. . . .	By this Bye-law the limits which divide the River of Sandwater from the sea are declared to be "a straight line from Binnaness to Burwick ; as regards the Stream running from the Lochs of Heulland and Burwick into the Voe of Burwick, a straight line from the most projecting point of land on the north side of the Voe to the Holm of Burwick, and thence southwards to the Point of The Pund ; as regards the Stream running into Bixter Voe, a straight line from Forraness to Rusaness ; as regards the Laxo and other Streams running into Dourie Voe, a straight line from Stava Ness to Dragon Ness ; as regards the Streams running into Vialin Voe, a straight line from Lunning Head to the Point of Lunna Ness ; as regards the Stream running into West Voe of Lunna, Swining Voe, Collafirth Voe, Dales Voe (Delting), Swinister Voe, Firths Voe, and Tofts Voe, a straight line from Lunna Ness to Mio Ness ; as regards the Stream running into the sea near Scalloway out of the Tingwall Lochs, a straight line from Scalloway to the north point of Trondra Island, and thence in a south-easterly direction to the shore of the Mainland ; as regards the Stream running into Dales Voe (Parish of Tingwall), the Stream running into the head of Laxfirth Voe, and the Streams running into Catfirth Voe and the Voe of Wadbister, a straight line from Kebister Ness to Glet Ness ; as regards the Wees running into Weesdale Voe, a straight line from Rusaness to Binnaness ; as regards the Stream running through Laxobigging into Garth's Voe, a straight line from Scatstaness to Bigg ; as regards the Stream running into Grutting Voe above the Bridge of Walls, a straight line from Whitesness to Culswickness ; as regards the Streams running into Sulem Voe, a straight line from Mio Ness to Ollaberry ; as regards the	11th May 1883.

Name of River.	*Limits of Estuary.*	*Date from which Bye-law took effect.*
River of Sandwater, &c.	Stream running into Busta Voe, a straight line from Busta to Hesda Ness; as regards the Streams running into Olnafirth Voe, a straight line from Hesda Ness to Grobs Ness; as regards the Streams running into Uriefirth, a straight line from Hillswick Ness to the south point of Swarta Skerry, and continued from thence to the nearest point of the Mainland; as regards the Streams running into Colifirth Voe, a straight line from Colifirth Ness to Queyfirth Ness; as regards the Streams running into Unyifirth, a straight line from Neing to Sonso Ness through the Island of Vementry; as regards the streams running into the sea at West Burrafirth, a straight line from Snarraness to Burrafirth; as regards the Streams running into Aith Voe, a straight line from Aith Ness to Selie Ness; as regards the Streams running into Foutabrough Voe, a straight line from Foutabrough to Braga Ness; as regards the Streams running into Vaila Sound, a straight line from Mucklure Ness to Whitesness through the Island of Vaila; as regards the Stream from the Loch of Gossawater running into Skelda Voe, a straight line from Skelda Ness to Reawick Ness; as regards the Stream running into Garderhouse Voe, a straight line from Forraness to Reawick; as regards the Streams running into the sea at Gulberwick, a straight line from Treibster Ness to Brindister Ness; as regards the Streams running into the Bight of Quarff, a straight line from the most projecting point of the Bight on the north to its most projecting point on the south; as regards the Streams running into the sea at Ocraquoy, a straight line drawn across the most projecting points of the bay; as regards the River of Vadsgarth running into the sea at the Sands of Mail, and the Burn of Voxter running into the sea at Aiths Voe, a straight line from Hely Ness to the Hoga, Burraland; as regards the Burn of Hoswick, the Burns of Channerwick and Claver running into the sea at Channerwick, and the Burn of Clumlie running into Troswick, a straight line from No Ness to Vaakel Craigs; as regards the Stream running into Quendale Bay, a straight line from Garth's Ness to Tolob; as regards the Stream running out of the Loch of Brow into the Loch of Spiggie, and from thence flowing into the sea, and the Stream running into the sea out of the Loch of Vatsetter, a straight line from Fora Ness to the Ness of Ireland, passing through St Ninian's Island; as regards the Stream running into Tresta Voe (Island of Fetlar), a straight line from Mouwick Head to Snap Point; as regards the stream running into Cullivoe (Island of Yell), a	11th May 1883.

Name of River.	*Limits of Estuary.*	*Date from which Bye-law took effect.*
River of Sandwater, &c.	straight line from Cullivoe-ness to a point due east of the Manse; as regards the Stream running out of the Loch of Gutcher, a straight line from Head of Gutcher to the point of the pier south of said Stream ; as regards the Stream running into Basta Voe (Island of Yell), a straight line from Burra Ness to Basta Ness ; as regards the Arisdale Burn running into Hamna Voe (Island of Yell), a straight line drawn from the Ness of Copister to the east side of the Ness of Gattagarth ; as regards the Streams running into Whalfirth Voe (Island of Yell), a straight line drawn due east from Graveland Ness ; as regards the Stream running out of Watley Loch (Island of Unst) into the Loch of Cliff, and from thence flowing into the sea at the head of Burrafiord, a straight line drawn from the west point of Hermaness till it meets the most projecting point of land on the east side of Saxafirth ; as regards the Streams running into Balta Sound (Island of Unst), a line drawn from the north-east point of Swinnaness, passing southwards and westwards through the Islands of Balta and Hunnie to the Sand at Clugan ; as regards the Stream running into the Voe of Snarravoe (Island of Unst) out of the Loch of Snarravoe, a straight line from Hoganess to Blue Mull; as regards the Streams running into the Bay of Belmont, a straight line from the Point of Sheetsberg on the east to the south-east Point of Oganess or Saxaburness on the west, which Points form the Bay of Belmont, otherwise known as Watswick ; as regards the Streams running into Uya Sound (Island of Unst), a straight line from Ramnagio, passing westward through the Island of Uya to the most projecting point of land on the west side of Uya Sound ; and as regards the other Streams, Voes, Bays, and Estuaries in the Fishery District of the Shetland Islands not herein specially mentioned, that their limits shall be defined by straight lines drawn in each case from the two extreme outward points of the Voe or Bay into which each River or Stream runs.	11th May 1883.

Name of River.	*Annual Close Time.*	*Extension of Time for Rod Fishing.*	*Date from which Bye-law took effect.*
River of Sandwater, &c.	From 10th Sept. to 24th Feb., both days inclusive.	From 1st Feb. to 24th Feb., both days inclusive ; and from 10th Sept. to 15th Nov., both days inclusive.	11th May 1883.

N.B.—The Bye-laws regulating the observance of the weekly close time by fixed nets; the size of meshes of nets to be used for the capture of salmon; the construction and use of mill dams, lades, cruives, &c.; apply to the foregoing rivers, just in the same way as they apply to the other rivers regulated by the Salmon Fishery Acts of 1862 and 1868 and relative Bye-laws.

Duartmore River.

An Estuary has recently been fixed for the Duartmore River, on the West Coast of Sutherland, by a Bye-law duly advertised, approved by the Secretary of State, and published in the *Edinburgh Gazette*. It is as follows:—

Name of River.	*Limits of Estuary.*	*Date from which Bye-law took effect.*
Duartmore	By the said Bye-law the limits which divide the River Duartmore, situated between Scourie on the north and Kylesku Ferry on the south, in the District of the River Laxford, including the estuary thereof, from the sea, are declared 'to be a straight 'line drawn from the point called the 'Point of the Raven's Rock, at the south 'end of the Island of Calvamore on the 'west, to Duartmore Point on the south 'side of Loch Sark on the east.'*	20th Feb. 1885.

* The annual close time for the Duartmore is the same as that for the Laxford—which see page 332—the Duartmore being within the limits of the District of the Laxford.

ANNUAL CLOSE TIME OF SCOTCH SALMON RIVERS under the Salmon Fishery Acts of 1862 and 1868 and relative Bye-Laws.

Since the publication of the above-mentioned Acts and relative Bye-Laws 11 Salmon Rivers have had their Annual Close Time altered; one by a Bye-Law drawn up by the Commissioners of Scotch Salmon Fisheries, and approved by the Secretary of State, and the remainder by Order under the hand of the Secretary of State, in terms of the 9th Section of 'The Salmon Fisheries (Scotland) Act, 1868.' It has, therefore, been judged advisable to give below a complete List of the Annual Close Times of the various Rivers down to February 1886. Those which have been altered by Order under the hand of the Secretary of State are placed together at the end of the List.

N.B.—Observe that, in the following List, the days fixing the commencement and termination of the Annual Close Time and of the Ex-

tension of Time for Rodfishing are, in all cases, inclusive, as in the case of the Add, the first River in the List.

Name of River.	*Annual Close Time.*	*Extension of Time for Rod Fishing.*	*Date from which Bye-law took effect.*
ADD	From Sept. 1 to Feb. 15, both days inclusive,	From Sept. 1 to Oct. 31, both days inclusive.	20th May 1864.
ALINE	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
ALNESS	From Aug. 27 to Feb. 10.	From Aug. 27, to Oct. 31.	14th Mar. 1865.
ANNAN (*see end of List*).			
APPLECROSS	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
ARNISDALE (*Loch Hourn*) . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
AWE	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Oct. 1864.
AYLORT (*Kinloch*) . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
AYR	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	13th June 1865.
BAA AND GLENCOILLEADER . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31	4th Aug. 1865.
BADACHRO and KERRY (*Gairloch*)	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	13th June 1865.
BALGAY and SHIELDAG . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
BEAULY	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.	7th Mar. 1865.
BERRIEDALE	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	29th Jan. 1864.
BERVIE	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	29th Jan. 1864.
BLADENOCH	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
BROOM	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	13th June 1865.
BRORA	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar 1865.
CARRADALE (in Cantyre) . .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	26th Jan. 1866.
CARRON	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
CLAYBURN, FINNISBAY, AVEN-NAN-GEREN, STRATHGRAVAT, NORTH LACASTILE, SCALLADALE, and MAWRIG (*East Harris*) . .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	19th June 1868.
CLYDE and LEVEN	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	7th Mar. 1865
CONON	From Aug. 27 to Feb.10.	From Aug. 27 to Oct. 31.	7th Mar. 1865.
CREE	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
CREED or STORNOWAY, and LAXAY (*Island of Lews*)	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	4th Aug. 1865.
CRERAN (*Loch Creran*) . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
CROWE and SHIEL (*Loch Duich*) .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	13th June 1865.
DEE (*Aberdeenshire*)	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	7th Mar. 1865.

Name of River.	*Annual Close Time.*	*Extension of Time for Rod Fishing.*	*Date from which Bye-law took effect.*
DEE (*Kirkcudbright*)	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	19th April 1864.
DEVERON	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	7th Mar. 1865.
DON	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	29th Jan. 1864.
DOON	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	14th Mar. 1865.
DRUMMACHLOY or GLENMORE (*Isle of Bute*)	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 15.	5th May 1868.
DUNBEATH	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.	11th Mar. 1865.
EARN (*see end of List*).			
ECKAIG	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 31.	20th May 1864.
ESK, NORTH	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 31.	14th Mar. 1865.
ESK, SOUTH	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 31.	1st Mar. 1864.
EWE	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
FINCASTLE, MEAVEG, BALLANACHIST, SOUTH LACASTILE, BORVE, and OBB (*West Harris*) . .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	19th June 1868.
FINDHORN	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 10.	7th Mar. 1865.
FLEET (*Sutherlandshire. See end of List*).			
FLEET (*Kirkcudbrightshire*) . . .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	20th May 1864.
FORSS	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	29th Jan. 1864.
FORTH	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.	14th Mar. 1865.
FYNE, SHIRA, and ARAY (*Loch Fyne*)	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 31.	11th Mar. 1865.
GIRVAN	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31,	29th Jan. 1864.
GLENELG	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
GOUR	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
GREISS, LAXDALE, or THUNGA .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	4th Aug. 1865.
GRUDIE or DIONARD	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
GRUINARD and LITTLE GRUINARD	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
HALLADALE (*see end of List*).			
HELMSDALE	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
HOPE and POLLA or STRATHBEG (*see end of List*).			
HOWMORE	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	8th Mar. 1872.
INCHARD	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
INNER *in Jura*	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	26th Jan. 1866.
INVER	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
IORSA *in Arran*	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	26th Jan. 1866.

Name of River.	Annual Close Time.	Extension of Time for Rod Fishing.	Date from which Bye-law took effect
IRVINE and GARNOCK . . .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	11th Mar. 1865.
KENNART	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
KILCHOAN or INVERIE (*Loch Nevis*)	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
KINLOCH (*Kyle of Tongue*) . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
KIRKAIG	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
KISHORN	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
KYLE of SUTHERLAND . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.	7th Mar. 1865.
LAGGAN and SORN (*Island of Islay*)	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	26th Jan. 1866.
LAXFORD	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
LEVEN	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
LITTLE LOCH BROOM . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
LOCHY	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	15th Nov. 1864.
LOCH DUICH	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	13th June 1865.
LOCH LUING	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	13th June 1865.
LOCH ROAG	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	4th Aug. 1865.
LOSSIE	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.	11th Mar. 1865.
LUCE	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	7th Mar. 1865.
LUSSA (*Island of Mull*) . . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	4th Aug. 1865.
MOIDART	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
MORAR	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
MULLANAGEREN, HORASARY, and LOCH-NA-CISTE (*North Uist*) .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	19th June 1868.
NAIRN	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.	7th Mar. 1865.
NAVER and BORGIE (*see end of List*)			
NELL, FEOCHAN, and EUCHAR .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
NESS	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.	7th Mar. 1865.
NITH (*see end of List*).			
RIVER from LOCH of STENNESS, &c. (ORKNEY ISLANDS) . . .	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	1st Sept. 1882.
ORMSARY (*Loch Killisport*) LOCH HEAD and STORNOWAY (*Mull of Cantire*)	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	4th Aug. 1865.
PENNYGOWAN or GLENFORSA, and AROS (*Island of Mull*) . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	4th Aug. 1865.
RESORT	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	4th Aug. 1865
RUEL	From Sept. 1 to Feb. 15.	From Sept. 1 to Oct. 31.	11th Mar. 1865.
SANDA	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.

Name of River.	*Annual Close Time.*	*Extension of Time for Rod Fishing.*	*Date from which Bye-law took effect.*
SCADDLE	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
RIVER of SANDWATER, &c. (SHETLAND ISLANDS)	From Sept. 10 to Feb. 24.	From Feb. 1 to Feb. 24; and from Sept. 10 to Nov. 15.	11th May 1883.
SHIEL (*Loch Shiel*)	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
SLIGACHAN, BROADFORD, and PORTREE (*Isle of Skye*)	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	4th Aug. 1865.
SNIZORT, ORLEY, OZE, and DRYNOCH (*Isle of Skye*)	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	4th Aug. 1865.
SPEY	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 15.	7th Mar. 1865.
STINCHAR	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	29th Jan. 1864.
STRATHY (*see end of List*).			
TAY	From Aug. 21 to Feb. 4.	From Aug. 21 to Oct. 10.	28th July 1865.
THURSO	From Aug. 27 to Feb. 10.	From June 11 to Feb. 10; and from 27 Aug. to 14 Sept.	11th Mar. 1865, and 2nd Nov. 1869.
TORRIDON, BALGAY, and SHIELDAG	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
UGIE	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	7th Mar. 1865.
ULLAPOOL (*Loch Broom*) . .	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	13th June 1865.
URR (*see end of List*).			
WICK	From Aug. 27 to Feb. 10.	From Aug. 27 to Oct. 31.	11th Mar. 1865.
YTHAN	From Sept. 10 to Feb. 24.	From Sept. 10 to Oct. 31.	29th Jan. 1864.

Rivers whose Annual Close Time has been altered by Order under the hand of the Secretary of State, in terms of the 9th section of 'The Salmon Fisheries (Scotland) Act, 1868.'

Name of River.	*Annual Close Time.*	*Extension of Time for Rod Fishing.*	*Date of publication of Order in 'Edinburgh Gazette.'*
FLEET (*Sutherlandshire*) . .	From Sept. 10 to Feb. 24, both days inclusive.	From Sept. 10 to Oct. 31, both days inclusive.	2nd Nov. 1877.
HALLADALE, STRATHY, NAVER, BORGIE, and HOPE . . .	From Aug. 27 to Feb. 10, both days inclusive.	From Jan. 11 to Feb. 10, both days inclusive, and from Aug. 27 to Sept. 10, both days inclusive.	3rd Sept. 1880.
EARN	From Aug. 21 to Feb. 4, both days inclusive.	From Aug. 21 to Oct. 31, both days inclusive.	14th July 1882.

Name of River.	*Annual Close Time.*	*Extension of Time for Rod Fishing.*	*Date from which Bye-law took effect.*
NITH	From Sept. 10 to Feb. 24, both days inclusive.	From Sept. 10 to Nov. 15, both days inclusive.	10th May 1872, and 31st Oct. 1884.
ANNAN	From Sept. 10 to Feb. 24, both days inclusive.	From Sept. 10 to Nov. 15, both days inclusive.	25th Aug. 1882, and 8th Aug. 1884.
URR	From Sept. 10 to Feb. 24, both days inclusive.	From Sept. 10 to Nov. 30, both days inclusive.	7th April 1885.

ARCHD. YOUNG,

Inspector of Salmon Fisheries for Scotland.

15*th March* 1886.

APPENDIX H.

NOTICE TO SEA FISHERMEN.

THE SEA FISHERIES ACT, 1883.

(46 AND 47 VICT., CAP. 22.)

A SUMMARY of the CHIEF REGULATIONS now in force under the above ACT and RELATIVE STATUTES. Prepared and issued for the guidance of Fishermen on the Scottish Coast, under the Authority of the FISHERY BOARD FOR SCOTLAND.

The Fishery Board for Scotland desires to call the attention of British Sea Fishermen to the Regulations enacted by the Sea Fisheries Act of 1883, and the International Convention (scheduled to the Act) between Great Britain, Germany, Belgium, Denmark, France, and the Netherlands, regulating the Police of the Fisheries in the North Sea outside territorial waters. For the purposes of the Act the 61st degree of north latitude is made the northern boundary of the North Sea , and for the information of our own fishermen, the following Statement has been prepared of the principal Regulations which, under the several Fishery Acts, fall now to be observed by them in fishing on the Scottish Coast, within or without the territorial waters.

Fishing Boats and Vessels.

1. All sea fishing boats must be registered, lettered, and numbered, in accordance with the Rules and Regulations for the different classes.
2. The certificates of registry must be kept on board the boat at all times (save when laid up), and must be produced annually for indorsation to an Officer of Customs, Coast Guard, or of the Fishery Board for Scotland.
3. The name of the boat and the port she belongs to must be painted on the outside of the stern, and the letters and numbers on the outside of each bow, and on each side of the principal sail above the close reef points. No other marks are allowed by the Convention on the outside of the hull or on the sails.

NOTE.—1. The name on the boat and the port to which she belongs must be painted on the stern, in white oil-colour on a black ground, in letters measuring 3 inches in height by ½-inch in breadth.

2. The initial letter or letters and registry number of the port must be painted on each bow, 3 inches below the gunwale, and on each side of the principal sail above the close reef points.

3. For boats of 15 tons burden and upwards the dimensions of the letters and numbers on the bows shall be 18 inches in height and 2½ in breadth, and on the sail one-third larger every way.

4. For boats of less than 15 tons burden, which may not have sufficient space below the gunwale, the distance will not be obligatory, but the dimensions of the letters and numbers on the bows shall be 10 inches by 1¾ inches respectively, and on the sails a third larger every way.

4. Small boats, buoys, and all fishing gear or implements must be marked in legible characters with the letters and numbers of the boat to which they belong; but owners of nets and other fishing implements may further distinguish them by any private marks they think proper.

5. The letters and numbers of a boat must not be covered or concealed in any way.

6. No boat must anchor between sunset and sunrise on ground where drift net-fishing is actually going on, except under compulsory circumstances.

Fishing Operations.

1. No boat shall shoot her nets or lines so as to interfere with the operations of another boat which has already commenced fishing.

2. The boat which has last shot her nets or lines will be held responsible for any damage she may do to a boat (or its gear) which had shot previously, unless they can prove that it was under compulsory circumstances, or that the damage was not caused by their fault.

3. When nets or lines belonging to different fishermen get foul of each other, they must not be cut without the consent of both parties, unless they cannot be otherwise disengaged; and lines so cut under stress of compulsory circumstances must be immediately joined together again. It is recommended that the same be done with nets.

4. No boat shall be made fast to the nets, lines, or fishing-gear of another fisherman.

5. No fisherman shall, under any pretext whatever, cut, hook, or lift up nets, lines, or other fishing gear not belonging to him, except in the cases of salvage and of fouling of nets and lines above referred to.

Salvage.

All wreck or fishing gear, marked or unmarked, picked up at sea, must be delivered to the proper authority at the first port touched at by the salving boat. This applies to all fishermen in the North Sea outside the territorial waters; and when any such wreck or fishing gear is picked up elsewhere by British fishermen, it should be immediately reported to the proper authority, who will give directions as to its disposal.

Trawling Vessels.

Trawlers must use every precaution to avoid doing damage to the nets or lines of other boats, and will be held responsible for any loss sustained, unless they can prove that it did not result from their fault.

Signal Lights.

1. Masters of sea fishing boats are warned to be careful in complying with the rules of the road at sea, and carry and exhibit such lights only as are authorised by the Board of Trade.

2. Masters are by law held responsible for the acts of all persons belonging to their boats.

Complaints.

Complaints for damage sustained to boats or fishing gear may be made to the following Officers, viz. :—The Commanders of Superintending Vessels; Officers of Custom House and Coast Guard; the Commanders of Fishery Cruisers; and the Officers of the Fishery Board for Scotland, who will, if required by both parties, fix the amount of compensation due

for any damage done to another fishing boat, or property belonging thereto.

Penalties.

1. For non-compliance with any of the regulations regarding registering, lettering, and numbering, boats may be seized whether at sea or in harbour, and the masters thereof are liable to a fine not exceeding £20.

2. Any fisherman who obstructs, disobeys, or refuses any information to any of the above-named officers in the execution of their duty, shall be liable to a penalty of £50, or imprisonment for not more than three months.

3. The Statute also enacts (sec. 4)—'If within the exclusive fishery limits of the British Islands *any person*, or if outside these limits *any person belonging to a British sea-fishing boat*, acts in contravention of the regulations contained in Arts. 13 to 22 inclusive of the Convention, he shall be liable on summary conviction to a fine not exceeding £50, or in the discretion of the Court to imprisonment for a term not exceeding three months, with or without hard labour.' In the foregoing summary the above regulations have been generally explained; but for the benefit of fishermen who may wish to possess a copy of the Articles themselves, they are here given entire.

ART. 13. The nationality of a boat must not be concealed in any manner whatsoever.

" 14. No fishing boat shall anchor, between sunset and sunrise, on grounds where drift-net fishing is actually going on.

This prohibition shall not, however, apply to anchorings which may take place in consequence of accidents or of any other compulsory circumstances.

" 15. Boats arriving on the fishing grounds shall not either place themselves or shoot their nets in such a way as to injure each other, or as to interfere with fishermen who have already commenced their operations.

" 16. Whenever, with a view of drift-net fishing, decked boats and undecked boats commence shooting their nets at the same time, the undecked boats shall shoot their nets to windward of the decked boats.

The decked boats, on their part, shall shoot their nets to leeward of the undecked boats.

As a rule, if decked boats shoot their nets to windward of undecked boats which have begun fishing, or if undecked boats shoot their nets to leeward of decked boats which have begun fishing, the responsibility as regards any damages to nets which may result shall rest with the boats which last began fishing, unless they can prove that they were under stress of compulsory circumstances, or that the damage was not caused by their fault.

" 17. No net or any other fishing engine shall be set or anchored on grounds where drift-net fishing is actually going on.

" 18. No fisherman shall make fast or hold on his boat to the nets, buoys, floats, or any other part of the fishing tackle of another fisherman.

" 19. When trawl fishermen are in sight of drift-net or of long-line fishermen, they shall take all necessary steps in order to avoid doing injury to the latter. Where damage is caused, the responsibility shall lie on the trawlers, unless they can prove that they were under stress of compulsory circumstances, or that the loss sustained did not result from their fault.

" 20. When nets belonging to different fishermen get foul of each other, they shall not be cut without the consent of both parties.

All responsibility shall cease if the impossibility of disengaging the nets by any other means is proved.

" 21. When a boat fishing with long lines entangles her lines in those of another boat, the person who hauls up the lines shall not cut them except under stress of compulsory circumstances, in which case any line which may be cut shall be immediately joined together again.

" 22. Except in cases of salvage and the cases to which the two preceding articles relate, no fisherman shall, under any pretext whatever, cut, hook, or lift up nets, lines, or other gear not belonging to him.

Foreign Sea Fishing Boats.

German, Belgian, Danish, French, and Dutch sea fishermen, when in the North Sea, or within British waters, are also required to obey the foregoing Rules, and can be punished for disregarding them.

By Order of the Board.

DUGALD GRAHAM, *Secretary.*

FISHERY BOARD FOR SCOTLAND,
EDINBURGH, 16*th June* 1885.

Copies of the Act may be obtained at the Offices of the Custom House, Coast Guard, and Officers of the Fishery Board for Scotland.

APPENDIX I.

RETURN OF COMPLAINTS made to the Officers of the FISHERY BOARD FOR SCOTLAND of Damage done by Trawlers or other Fishing Boats to the Boats, Nets, Lines, or Gear of Fishermen, from the date of the passing of the Sea Fisheries (Scotland) Amendment Act, 1885, to the present time.

Date of Offence.	Nature of Complaint.	Locality, and Distance from Shore.	Whether Inside or Outside Territorial Waters.	Steps taken.	Results.
	EYEMOUTH DISTRICT.				
1885. Nov. 2	3600 yards lines, value £8, lost through trawler 'Blucher,' S.N. 1495.	21 miles E.N.E. off Eyemouth.	Outside.	Officer communicated with master and owner of trawler.	Compromised by complainer accepting £5 in full of all damage done.
	ANSTRUTHER DISTRICT.				
Aug. 26	Damage to herring nets by trawler 'Adonis' of North Shields.	$\frac{1}{2}$ mile W. from May Island.	Inside.	Investigation and report by officer, who estimated damage at £11, 15s. Prosecution by Fiscal.	Decided in favour of trawler; boat not having had lights as required.
Sept. 21	Damage to haddock lines by trawler 'Sea King,' Granton.	2 miles off St Monance.	Inside.	Investigation and report by officer, who estimated damage at £6, 13s. Prosecution by Fiscal.	Master of trawler fined £5, and damage of £6 13s. as assessed awarded.
Sept. 21	Damage to haddock lines by trawler 'Sea King,' Granton.	2 miles off St Monance.	Inside.	Investigation and report by officer, who estimated damage at £6, 6s. 8d. Prosecution by Fiscal.	Damage as assessed awarded.
Sept. 21	Damage to haddock lines by trawler 'Sea King,' Granton.	2 miles S.W. from Pittenweem.	Inside.	Investigation and report by officer, who estimated damage at £1, 18s. Prosecution by Fiscal.	Damage as assessed awarded.

APPENDIX I.—*continued.*

Date of Offence.	Nature of Complaint.	Locality, and Distance from Shore.	Whether Inside or Outside Territorial Waters.	Steps taken.	Results.
1886. Jan. 20	Damage to herring nets by trawler 'Livingstone,' L.H. 1004.	1 mile W. from May Island.	Inside.	Investigation by officer, who estimated damage at £2, 10s. and found defender at fault.	Trawler remitted full amount of estimated damage to officer, who paid it to complainant.
Jan. 23	Damage to herring nets by one boat fouling with another.	½ mile S. from May Island.	Inside.	Investigation by officer, who estimated damage at £1, 10s.	Damage unavoidable—neither party to blame.
Feb. 17	Damage to haddock lines by trawler 'Buccleuch,' G.N. 6.	2 to 3 miles E. from May Island.	Inside.	Investigation and report by officer, who estimated damage at £10, 9s. 6d. Prosecution by Fiscal.	Case not yet decided.
Feb. 17	Damage to haddock lines by trawler 'Buccleuch,' G.N. 6.	2 to 3 miles E. from May Island.	Inside.	Investigation and report by officer, who estimated damage at £5, 16s. Prosecution by Fiscal.	Case not yet decided.
Feb. 17	Damage to haddock lines by trawler 'Buccleuch,' G.N. 6.	2 to 3 miles E. from May Island.	Inside.	Investigation and report by officer, who estimated damage at £4, 7s. 6d. Prosecution by Fiscal.	Case not yet decided.
Feb. 24	Damage to great lines by trawler 'Bruce,' G.N. 10.	1 mile S.W. from May Island.	Inside.	Investigation and report by officer, who estimated damage at £7, 5s. Prosecution by Fiscal.	Master of trawler fined 20s. and full amount of damage as assessed awarded. Case appealed.
Feb. 24	Damage to great lines by trawler 'Douglas,' G.N. 14.	1 mile S.W. from May Island.	Inside.	Investigation and report by officer, who estimated damage at £3, 2s. Prosecution by Fiscal.	Case withdrawn, evidence being insufficient.
Feb. 25	Rudder of boat at anchor, broken by another boat.	Close to the North side of the May Island.	Inside.	Investigation by Officer, and damage estimated at 20s.	Found that complainer could have avoided damage by removing rudder. Damage not allowed.

APPENDIX I.—*continued.*

Date of Offence.	Nature of Complaint.	Locality, and Distance from Shore.	Whether Inside or Outside Territorial Waters.	Steps taken.	Results.
Feb. 26	Damage to haddock lines by trawler 'William Scott,' S.N. 1100.	½ mile W. from May Island.	Inside.	Officer investigated case, who estimated damage at £1 15s., and found defender at fault.	Trawler remitted full amount of damage, which was paid to fisherman.
Mar. 8	Damage to great lines by trawler 'William Fenwick,' L.H. 975.	2 miles S.W. from May Island.	Inside.	Officer investigated and reported case, and estimated damage at £10, 8s. 3d. Prosecution by Fiscal.	Trawler found not guilty.
	STONEHAVEN DISTRICT.				
1885. Aug. 24	Damage to nets by fishing boat.	30 miles E.S.E.	Outside.	Inquiry by officer, who estimated damage at 12s., and found defender at fault.	Defender admitted fault, and paid the estimated amount, but which the complainant returned.
Nov. 7	Hauling great lines and appropriating fish by fishing boat.	4 miles E.	Outside.	Inquiry by officer.	Complainer withdrew the case.
Dec. 14	Anchoring great lines on herring grounds.	½ mile E.	Inside.	Inquiry by officer.	Complainer withdrew the case.
1886. Mar. 11	Cutting fishing gear by fishing boat.	4 miles E.	Outside.	Inquiry by officer, who estimated damage at 7s., and found defender at fault.	Damage as estimated paid to complainer.
	BANFF DISTRICT.				
1885. Nov. 12	1 buoy carried away by line boat 'Barbara and Jane' of Port Knockie, B.F. 634.	'The Gripes,' 4 miles E.N.E. off Macduff.	Outside.	Officer investigated case, and estimated damage at 5s.	Defender denied charge, and case withdrawn.

APPENDIX I.—*continued.*

Date of Offence	Nature of Complaint.	Locality, and Distance from Shore.	Whether Inside or Outside Territorial Waters.	Steps taken.	Results.
	BUCKIE DISTRICT.				
1885. Oct. 1	4½ lines carried away from boat by trawler 'Clyde,' S.H. 18.	'Reef' 14 miles S.S.E. off Clythness.	Outside.	Officer investigated case, who estimated damage at £10, and found defender at fault.	Settled by complainer accepting £5.
Oct. 2	4½ lines cut adrift from a fishing boat by another fishing boat.	22 miles N.N.E. off Logiehead	Outside.	Officer investigated case, who estimated damage at £2, 10s., and found defender at fault.	Settled by complainer accepting 24s.
Nov. 5	2 lines carried away from a fishing boat by another fishing boat.	'Smith Bank' 30 miles N.E. off Buckie.	Outside.	Officer investigated case, who estimated damage at £2 or new lines to be supplied, and found defender at fault.	Complainer accepted 2 new lines as compensation.
Nov. 5	1 line carried away from fishing boat by trawler 'Dauntless,' S.N. 1381.	'Reef' 14 miles S.S.E. off Clythness.	Outside.	Officer investigated case, who estimated damage at £3, and found defender at fault.	Settled by complainer accepting £2.
Nov. 5	1 line carried away from fishing boat by trawler 'Dauntless,' S.N. 1381.	'Reef' 14 miles S.S.E. off Clythness.	Outside.	Officer investigated case, who estimated damage at 15s., and found defender at fault.	Settled by damage being paid as estimated.
Nov. 18	2 lines and buoy carried away from fishing boat by trawler 'Sarah Smart,' S.S.S. 271.	'Smith Bank' 30 miles N.E. off Buckie.	Outside.	Officer investigated case, who estimated damage at £4, and found defender at fault.	Settled by complainer accepting £3.
Dec. 18	2 lines and buoy carried away from fishing boat by another fishing boat.	'Little Feer' about 16 miles S.S.E. off Clythness.	Outside.	Officer investigated the case, who estimated damage at £3, 3s. 6d., and found defender at fault.	Settled by complainer accepting 14s.
1886. Jan. 15	One fishing boat tearing the nets of another.	4 miles off Berriedale.	Outside.	Officer investigated case.	Charge found not proven.
Feb. 23	The lines of one boat cut by the crew of another boat.	16 miles off Nosehead.	Outside.	Officer investigated case.	Charge found not proven.

APPENDIX I.—*continued.*

Date of Offence.	Nature of Complaint.	Locality, and Distance from Shore.	Whether Inside or Outside Territorial Waters.	Steps taken.	Results.
Mar. 9	6 lines carried away from a fishing boat by the trawler 'Southesk,' M.E. 696.	'Smith Bank' 30 miles N.E. off Buckie.	Outside.	Officer investigated case, who estimated damage at £6, 10s., and found defender at fault.	Settled by complainer accepting £3, 10s.
Mar. 25	16 lines and 7 buoys carried away from a fishing boat by the trawler 'Dauntless,' S.N. 1381.	'Smith Bank' 30 miles N.E. off Buckie.	Outside.	Officer communicated with agent and captain of 'Dauntless,' and estimated damage at £17, 12s.	Case not yet settled.
Mar. 31	3 lines carried away from a fishing boat by the trawler 'Bennachie,' L.O. 333.	6 miles off Clythhead.	Outside.	Officer investigated case, who estimated damage at £2, 5s., and found defender at fault.	Case not yet settled.
	LYBSTER DISTRICT.				
Mar. 4	Loss of 3 cod fishing lines carried away by steam trawler 'Tyne,' of Scarborough, S.H. 93.	About 3 miles off Clythness.	Inside.	Officer investigated case, who estimated loss at £5, 11s. 6d., and found defender at fault.	Settled by complainers accepting £2, 7s. 6d.
	WICK DISTRICT.				
Feb. 5	Carrying away of lines by trawler 'Mure,' M.E. 659.	5 miles off Wick.	Outside.	Officer investigated case, who estimated damage at £5, 10s., and found defender at fault.	Estimated amount paid by trawler.
Feb. 6	Carrying away of lines by trawler 'Bonito,' A 93.	3 miles off Sandside.	Inside.	Officer investigated case, who estimated damage at £11, and found defender at fault.	Case not yet settled.
Feb. 6	Carrying away of lines by trawler 'Bonito,' A 93.	$2\frac{1}{2}$ miles off Sandside.	Inside.	Officer investigated case, who estimated damage at £12, and found defender at fault.	Case not yet settled.
Feb. 6	Carrying away of lines by trawler 'Bonito,' A 93.	$2\frac{1}{2}$ miles off Sandside.	Inside.	Officer investigated case, who estimated damage at £18, and found defender at fault.	Case not yet settled.

APPENDIX I.—*continued.*

Date of Offence.	Nature of Complaint.	Locality, and Distance from Shore.	Whether Inside or Outside Territorial Waters.	Steps taken.	Results.
Feb. 11	Carrying away of lines by trawler 'Rosa,' M.E. 660.	3 miles off Nosshead.	Inside.	Officer investigated case, who estimated damage at £2, 10s. 6d., and found defender at fault.	Settled by owner of trawler paying £2.
Feb. 11	Destroying nets by fishing boat W.K. 398.	2½ miles off Wick.	Inside.	Officer wrote owner of boat, who estimated damage at £2, 10s., and found defender at fault.	Owner of boat paid £1. £1 10s. still due.
Feb. 11	Destroying nets by fishing boat W.K. 411.	2 miles off Lybster.	Inside.	Officer wrote owner of boat, and estimated damage at £7, 14s. 6d.	Claim departed from.
Feb. 18	Carrying away of lines by trawler 'Benachie,' L.O. 333.	5 miles off Wick.	Outside.	Officer wrote owner of trawler, and estimated damage at £4, 10s.	Case settled by trawler paying £3.
Feb. 23	Carrying away of lines by fishing boat B.F. 53.	7 miles off Wick.	Outside.	Officer wrote owner of boat, and estimated damage at £1.	Case settled by line being returned.
Feb. 24	Carrying away of lines by trawler 'Palmerston,' A. 328.	4 miles off Wick.	Outside.	Officer wrote owner of trawler, and estimated damage at £3.	Case settled by trawler paying £1, 10s.
Mar. 5	Carrying away of lines by trawler 'Sarah Smart,' S.S.S. 271.	4 miles off Wick.	Outside.	Officer wrote owner of trawler, and estimated damage at £2.	Case settled by trawler paying £1, 10s.
	FORT-WILLIAM DISTRICT.				
1885. Oct. 22	Disturbance between drift and seine-net fishermen at Loch Eil, the former took possession of a boat with herrings belonging to the latter, and distributed the herrings among them; also destroyed a seine-net to the value of about £7, besides otherwise interfered with the crews of two trawlers.	About ¼ of a mile from shore.	Inside.	The matter was reported to Procurator-Fiscal at Fort-William.	Several of the drift-net fishermen were fined £1 each, or so many days imprisonment. The fines were paid.

APPENDIX I.—*continued.*

Date of Offence.	Nature of Complaint.	Locality, and Distance from Shore.	Whether Inside or Outside Territorial Waters.	Steps taken.	Results.
	BALLANTRAE DISTRICT.				
1886. Feb. 5	Lines of fishing boat A.R. 333 cut by trawler 59 C.K. (Colchester).	3 miles off Girvan.	Inside.	Officer inquired into the matter. Estimated the damage at £3, and reported case to Commander of 'Jackal.'	Trawler not identified.
Feb. 12	Nets of boat A.R. 309 cut by trawler L.L. 42 (Liverpool).	5 miles off Girvan.	Outside.	Officer inquired into the matter. Estimated the damage at £1, and reported case to Commander of 'Jackal.'	Trawler not found.
Feb. 12	Cod net of boat A.R. 101 cut by trawler L.L. 42 (Liverpool).	5 miles off Girvan.	Outside.	Officer inquired into the matter. Estimated the damage at £1, 10s., and reported case to Commander of 'Jackal.'	Trawler not found.
	FISHERY CRUISER 'VIGILANT.'				
1885. Aug. 17	Collision between W.K. 188, and L.H. 112.	Entrance to Aberdeen Harbour.	Inside.	Complaint investigated by Commander.	Compensation paid to complainer W.K. 188.
Aug. 17	Collision between W.Y. 47, and B.H. 1117.	5 miles S.E. from Girdleness.	Outside.	Complaint investigated by Commander.	Each owner to pay half cost of repair.
Aug. 19	Damage to small boat W.K. 957 by B.H. 1089.	Castlebay.	Inside.	Complaint investigated by Commander.	Compensation paid to complainer.
Aug. 22	Damage to nets.	10 miles S.E. from Aberdeen.	Outside.	Complaint investigated by Commander.	Arranged by parties themselves.
Aug. 24	Damage to nets.	15 miles S. from Aberdeen.	Outside.	Complaint investigated by Commander.	No evidence against accused.
Aug. 28	Damage to nets. P.D. 191 *v.* P.D. 298.	Uncertain.	Outside.	Latter boat could not be found.	

APPENDIX I.—*continued.*

Date of Offence.	Nature of Complaint.	Locality, and Distance from Shore.	Whether Inside or Outside Territorial Waters.	Steps taken.	Results.
Aug. 31	Collision between P.D. 130 and K.Y. 39.	8 miles off Aberdeen.	Outside.	Complaint investigated by Commander.	Complaining party to blame.
Sept. 4	Fouling patent log. A. 538 *v.* A. 509.	15 miles S. by E. off Aberdeen.	Outside.	Complaint investigated by Commander.	Accused found in fault.
Sept. 4	Damage to nets. I.N.S. 889 *v.* A. 107.	10 miles S.S.E. off Aberdeen.	Outside.	Complaint investigated by Commander.	Accused found in fault.
Sept. 10	Damage to nets. P.D. 695 *v.* P.D. 471.	Off Cairnbulg.	Inside.	Complaint investigated by Commander.	Damage unavoidable.
Sept. 11	Collision. P.D. 192 and P.D. 824.	At sea.	Outside.	Complaint investigated by Commander.	Latter boat found to be in fault.
Sept. 15	Damage to nets. A. 2 *v.* P.D. 67.	At sea.	Outside.	Complaint investigated by Commander.	Complainer failed to appear.
1886. Jan. 25	Damage to nets. K.Y. 286 *v.* Geo. Hughes, Pittenweem.	2 miles off May Island.	Inside.	Complaint investigated by Commander.	Complainer himself at fault.
Feb. 26	Damage to nets. L.H. 1044 *v.* A. Peebles, Pittenweem.	1 mile off May Island.	Inside.	Complaint investigated by Commander.	No evidence, complaint withdrawn.
	H.M.S. 'JACKAL.'				
1885. Aug. 31	Beam trawlers interfering with drift-net fishing and line fishing in the Bay of Luce.	Luce Bay.	Inside.	'Daisy' cutter despatched from Loch Fyne to investigate. Trawlers declared damage to set nets and lines was consequent on insufficient buoying and marking, but expressed intention of leaving the ground.	Trawlers left the ground.
Nov. 18	Beam trawlers interfering with nets and lines of Ballantrae fishermen.	5 miles off Ballantrae.	Outside.	'Jackal' proceeded to Ayrshire coast. Found reports groundless, no beam trawlers having been on the coast since June.	

FISHERY BOARD FOR SCOTLAND, EDINBURGH, 1*st May* 1886.

DUGALD GRAHAM, *Secretary.*

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1886.